

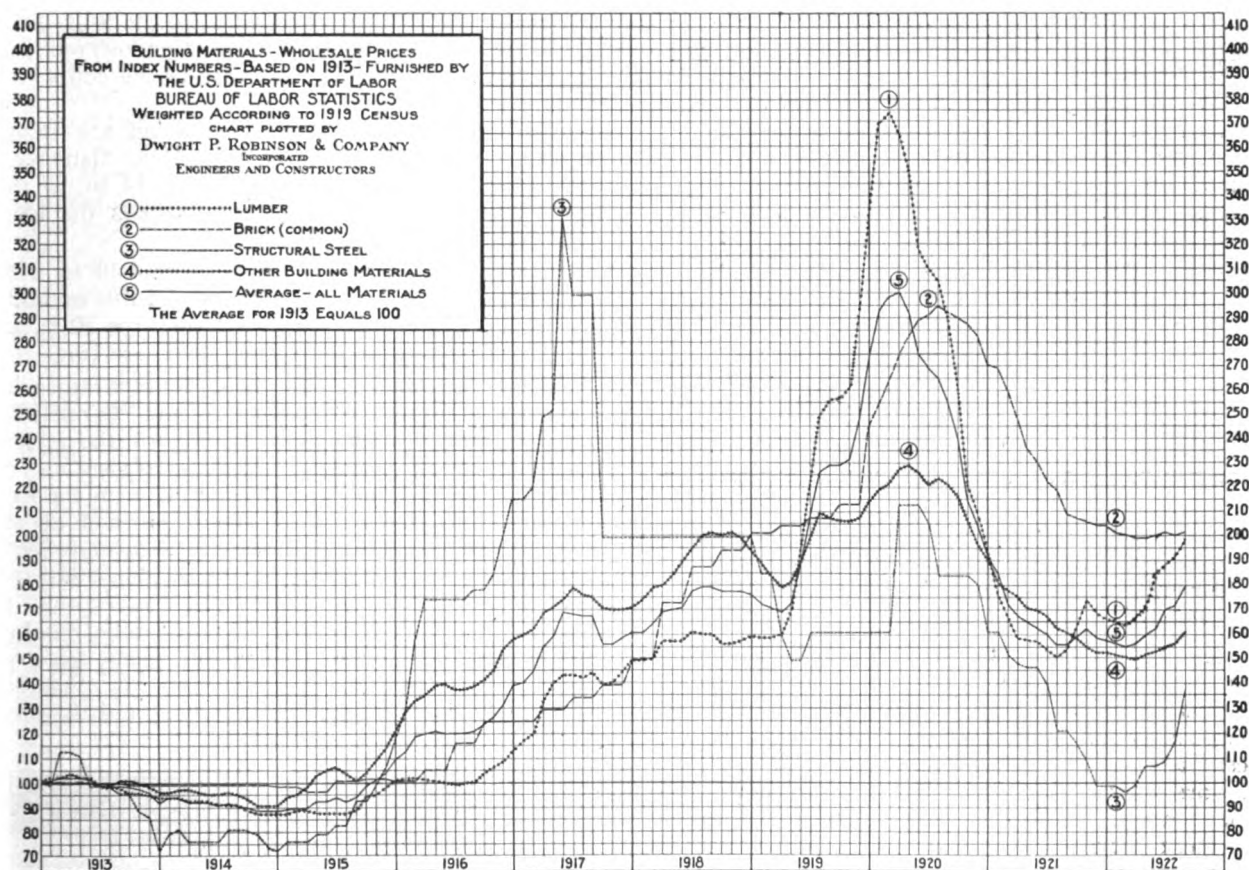
The Blast Furnace *and* Steel Plant

Vol. XI

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No. 4

The Position of Steel



Relative Wholesale Prices

The curves shown above give at a glance the relations existing between the various fundamental items entering into the building program. When we record the additional fact that more than \$5,000,000,000 was thus invested last year and an even greater total will be involved during the year 1923, the importance of these relations becomes apparent.

The chart is shown because it emphasizes the favorable position of steel, structural steel being not much

above the quotations current before the war period. It fully explains the reported low profits of steel manufacturing companies during 1921 and 1922, and the lowered scale of labor wages in the industry compared with wages in building trades as well.

The influence of these widely varying factors upon business in general should be carefully observed as the spring program brings inevitable advances in steel prices, accompanied by labor shortages and wage demands.

New Eastern Mill for Rolling Alloys

Many Combinations Present Complications as Various Melting Points and Rolling Temperatures Must Be Contended With—
Electric Furnaces for Melting and Refining.

By E. COOPER WILLS*

THE new hot rolling mills, designed, built and put in operation for the Driver-Harris Company by the writer have been turning out alloy metals and steel in wire rod, strip, sheet and merchant stock since September 22.

The alloy metals consist of nickel and chrome, copper and nickel, pure nickel; nickel, chrome, manganese

The increasing demand in the East for tonnages of various alloy metals, will be taken care of by the recently finished Hot-Rolling Mills of the Driver Harris Company.

This motor driven mill layout was designed, built and put in service September 22 under the direct supervision of the writer. Pure nickel, nickel-chrome, copper-nickel, nickel-chrome-manganese-carbon, manganese-aluminum, copper-manganese-nickel, and others, all having different melting points and rolling temperatures will be turned out in various sizes, thicknesses and lengths.

and carbon; copper, manganese and aluminum; copper, manganese and nickel, etc., all having different melting points and rolling temperatures.

Electric furnaces are used in melting and refining the alloy metals, and considerable skill is required in this operation as the electric arcs penetrate the bath of metal at approximately 5,000 deg. F., which is above the burning or oxidizing point of the metals; this necessitates a cleaning of the metal before it is tapped into the ladle and poured. If this is done properly these metals will roll and draw with little or no trouble.

It might be added that the neutral atmosphere spoken of in the electric furnace is a good deal of a misnomer, as practically all metals contain enough oxygen to oxidize the metal when the arc penetrates the metal, hence the metal must be cleaned while refining.

The mill buildings are of steel construction. From the lower chord of truss to the mill floor is 22 ft. 6 in. The truss construction above the mills is sufficiently heavy to carry electric cranes for changing rolls.

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These cranes are operated from the floor by the roll crews, and change rolls in both trains at the same time when required.

Rolling Mill Equipment.

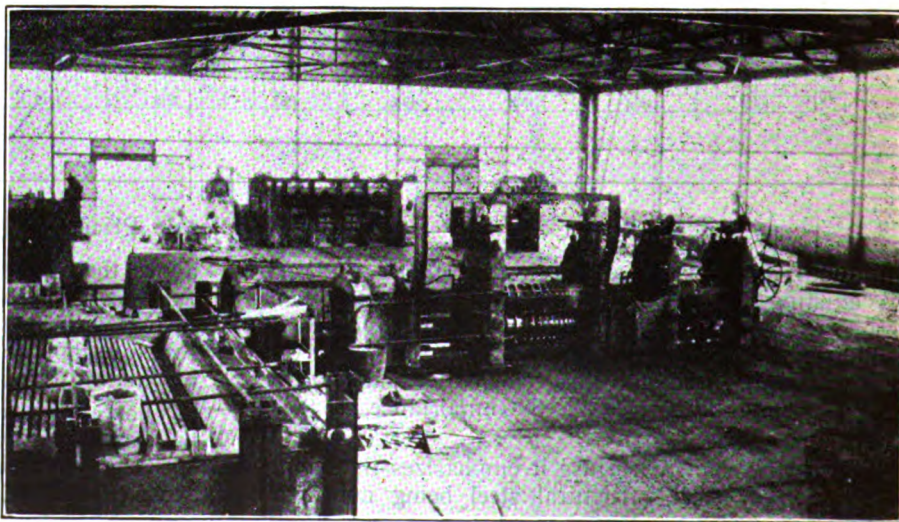
The rolling mill equipment consists of one two-stand 20-in. mill and one nine-stand 9-in. mill with reel synchronized with or direct connected to the 9-in. mill. The reel drum is operated by air (raised or lowered); the reel proper runs continuously and throws the coil around the drum.

The rolls in each successive stand are stepped up larger in diameter, beginning with 9-in. diameter in the first stand and having a diameter of 14 in. in the bull-heads or finishing stand. This shortens the loops and does not require hook runners.

The pits on each side of the 9-in. mill in which the loops are run start 5 ft. on each side of this mill and drop on an incline of 25 deg. in 25 ft., then for 30 ft. at $\frac{1}{8}$ of an inch per foot; the remaining 10 ft. are level.

Eight-inch channels are used as separators between the loops. Flanges are turned in and channels brought together in a V-shape near the top of the pits and all are bolted down to rolled never-slip plates laid on concrete floor. All floors are of concrete with the exception of the floors above the pits. These are made up of 18-in. I-beams, 5-ft. centers covered with $\frac{1}{2}$ -in. rolled never-slip plates. All plates are bolted at joints with counter-sunk bolts.

The first or break-down stand of rolls on the 20-in. mill consists of three box passes which are graduated down with open squares to 1 9/16 in. Starting with 7x7-in. ingots, from the break-down stand the piece goes



New 20-in. mill of the Driver-Harris Company at Newark, N. J.

to the second stand of strands, open squares and ovals; the last oval on this stand takes the first stand of open squares on the 9-in. mill and alternate ovals and open squares, finishing oval and round to reel.

In rounds from $\frac{1}{2}$ in. to and including $\frac{3}{4}$ in., three stands are used on the 9-in. mill, open square, finishing oval and round.

Three box passes are put in the break-down stand in order not to get under the neck size of rolls, which is 14 in. In working the soft alloys less passes are used in the break-down stand and heavier reductions are made.

On strip up to 3 in., five stands are used on the 9-in. mill; sizes above this are done on the 20-in. mill.

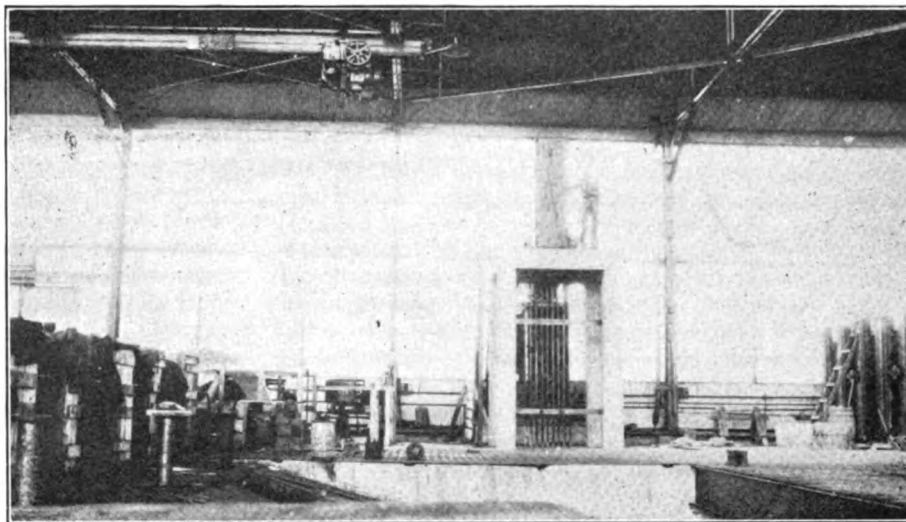
Motor Drives and Gears.

An 800-hp. d.c. motor is used with a gear reduction of $8\frac{3}{4}$ to 1 on the 20-in. mill with a speed ratio of 600 to 300. A 500-hp. d.c. motor is direct connected to the 9-in. mill with a speed ratio of 600 to 300, and with a solid steel flywheel 8 ft. in diameter and weighing 14,000 lbs. This mill running idle pulling the ree takes 60 amperes at 600 volts, or about 48 hp., giving over 450 hp., which is ample to take care of work on this mill.

From the center of the 20-in. mill to the center of the 9-in. mill is 78 ft. Using a 50-lb. billet, this brings the

last oval from the 20-in. mill to the small cropping shear at the 9-in. mill.

All shears, straightening rolls, draw-bench and small tools are so spaced that the operations are continuous



Central pulpit of 9-in. and 20-in. mills, showing part of the 9-in. mill.

with 5 ft. clearance between each operation; stock starts at one end of plant and finishes upon the scales at the other end.

Both mills are controlled by an operator on the pulpit which stands in the clear between the mills. A push button or remote control is located on the mill housings for stopping the mills in case of accident.

CHAMBER OF COMMERCE OF THE UNITED STATES PRESS SERVICE

Twelve rules for testing the value of a cost accounting system are set down in a pamphlet issued today by the Fabricated Production Department of the Chamber of Commerce of the United States.

A cost accounting system, according to the pamphlet is very much like the engine of an automobile, only "there are more kinds of cost systems than gas engines and their vagaries and non-performances are just as many—if you have not the right kind."

"A car that doesn't operate right," the pamphlet goes on to say, "costs a lot in repairs, and a cost system that fails to show what it should, consumes profits."

"It will pay to check out on your system as you would on your car. You ought to know the upkeep and if it pays."

The rules to apply in analyzing the soundness of a cost system as set forth in the pamphlet are:

Does your cost system give you up-to-date costs, not merely history?

Does it aid in stabilizing your wages and piece-work rates?

Does it point out defects in your routing system?

Does it help you maintain a perpetual inventory?

Does it increase your production?

Does it measure your overhead?

Does it detect new overhead expense?

Does it point out leaks in expense?

Does it encourage your employees?

Does it promote intelligent competition?

Does it point to non-profit paying lines?
Does it permit you to bid safely?

MEETING OF ELECTRIC STEEL FOUNDERS' RESEARCH GROUP

The Electric Steel Founders' Research Group held one of its regular meetings in Detroit recently. The Group is composed of the Electric Steel Company (of Chicago), Fort Pitt Steel Casting Company, Lehanon Steel Foundry, Michigan Steel Casting Company, and Sivyer Steel Casting Company.

Officers and operating officials of each of these steel foundries discussed the reports which were presented at this meeting, on investigations being carried on at the different plants. The more important ones in progress now are said to be those on electric furnace practice, core practice and facing practice. The discussions, while giving full weight to theoretical considerations, were especially characterized by regard for practical application.

The Group decided to expand the scope of its work and to provide for greater activity on the part of its Committee on New Uses for Steel Castings. For this purpose W. J. Corbett was engaged as industrial engineer to be associated with R. A. Bull, research director, in the increased activities of the Group in its comprehensive research work.

Mr. Corbett's engineering training was supplemented by several years' of experience in plants of the American Steel Foundries, also in the steel foundries of the Watertown Arsenal and the Erie Forge Company. Mr. Corbett's headquarters will be at the Group's central office, 639 Diversey Parkway, Chicago.

Speed Control of Polyphase Motors

In the First Section, Published in March, Variable Frequency, Multi-Speed, Cascade-Sets, Rheostatic, and Primary Voltage Were Described in Detail.

By GORDON FOX*

PART II—DYNAMIC CONTROL

THE torque of an induction motor is developed by current in the rotor conductors reacting upon the primary magnetism. The primary magnetism of an induction motor remains practically constant. In order to develop various values of torque as demanded by an external load, the rotor current must vary. This is brought about in the ordinary motor by small changes in the slip such that the voltage generated in the rotor circuit is varied and the current automatically adjust-

lowers that the frequency of the counter voltage must vary in like manner.

Dynamic control is a name given to all the methods of induction motor speed control involving the use of auxiliary machines arranged to introduce a counter voltage into the secondary circuit and to transfer the secondary or slip energy of the main, wound rotor motor back to the source of supply or to convert it to mechanical power and apply it to the shaft of the main motor. There are several methods in use. These may be classified according to the auxiliary equipment required as follows:

Rotary converter or Kramer system.

A.c. commutator motor or Scherbius system.

Frequency converter system.

The Kramer System.

The Kramer system employs a rotary converter to convert the slip energy of the main motor to d.c. This

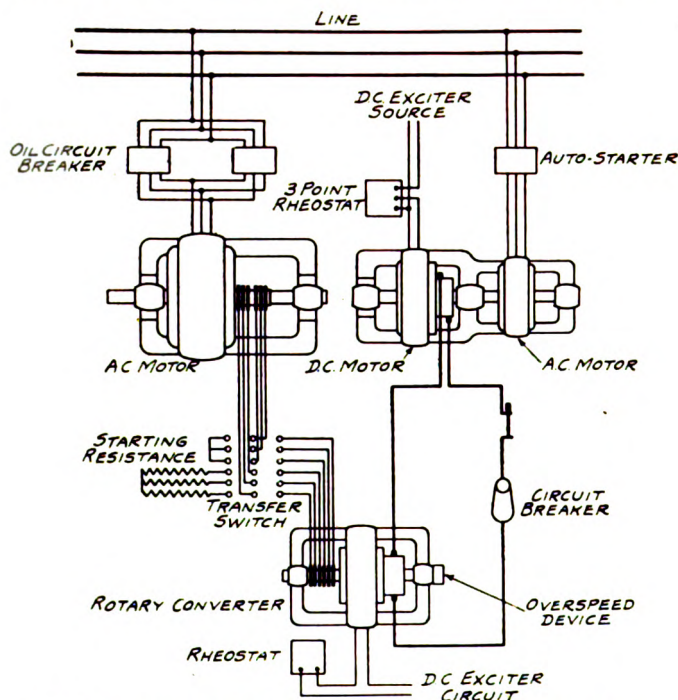


FIG. 8—Dgm. principal connections for Kramer system with motor generator set.

ed to the load. The rotor circuit, then, has a generated voltage overcoming the rotor resistance. Let us consider what will occur if, in addition to the rotor resistance, a counter voltage is introduced into the rotor, the value of this counter voltage being adjustable. A given torque still requires a given current and sufficient margin must exist between generated voltage and counter voltage to force the required current through the secondary circuit resistance. The greater the counter voltage the greater the generated voltage required, hence the greater the rotor slip. It is thus seen that it is possible to vary the speed of an induction motor materially by introducing a counter voltage in the secondary circuit. Since the frequency of the secondary circuit is variable, dependent upon the slip, it fol-

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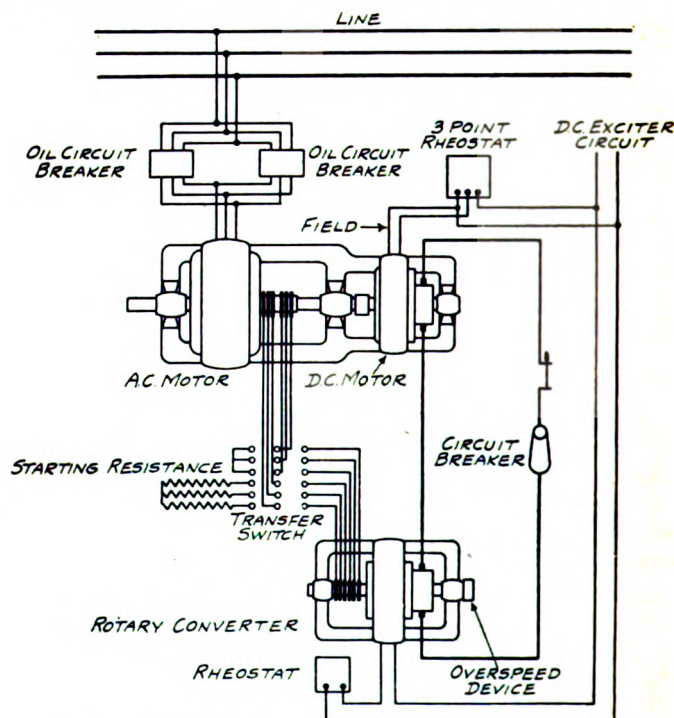


FIG. 9—Dgm. principal connections for Kramer system with auxiliary direct current motor.

is then used in a d.c. current motor. This motor may be part of a motor generator set or it may be attached to and made a part of the main induction motor drive. The layout and main connection for the rotary converter motor generator system are shown in Fig. 8. The operation is as follows: As starting, the main

motor is operated alone with the switch A thrown to connect the external resistance in the secondary circuit and the motor is accelerated in the usual manner by cutting down the secondary resistance. To place the auxiliary apparatus in service, the induction motor of the motor generator set is started. The field of the direct current unit is reduced to zero so that the set merely runs light from the a.c. side. Normal field current, obtained from an exciter, is placed upon the converter, which is at rest. While the main motor is running light at full speed with small slip, the switch A is thrown over to disconnect the resistance and substitute therefore the alternating current side of the converter. The converter starts to rotate very slowly since it runs in synchronism with the slip of the main motor. The d.c. side of the converter is then connected to the d.c. unit of the motor generator set by closing switch B. This completes all circuits and places the system in readiness for speed adjustment.

If the field of the d.c. unit, 3, be strengthened it will generate a voltage which is impressed upon the d.c. end of the converter. This increases the voltage at the a.c. end of the converter and introduces a counter voltage into the secondary circuit of the main motor, slowing it down. This increases the slip frequency and causes the converter to increase its speed but it does not affect the voltage ratio of the converter. The stronger the excitation of the d.c. unit, the greater the counter voltage introduced into the secondary circuit of the main motor. By adjustment of the field rheostat of the d.c. unit 3 it is possible to adjust the speed of the main motor for any desired rate below synchronism. With a given rheostat setting the speed of the main motor remains nearly constant, affording characteristics similar to those of an adjustable speed d.c. shunt motor.

This scheme can also be used to increase the speed of the main motor above synchronism. As the field of the d.c. unit is weakened the speed of the main motor rises. If the field of the d.c. unit be reversed, the direction of rotation of the converter is reversed. The voltage applied to the secondary of the main motor is also reversed so that, instead of being a counter voltage opposing the flow of rotor current, it aids the flow. It is no longer necessary for the rotor to slip below synchronous speed to generate a voltage to set up the flow of rotor current. The rotor therefore speeds up above synchronism. In doing so it cuts the magnetism of the stator's revolving field in opposite sense from that existing below synchronism and thus generates a counter voltage. The more the field of the d.c. unit is strengthened the greater the voltage impressed at the slip rings encouraging the flow of rotor current. The higher, then, the speed must be in order that a counter voltage may be generated sufficient to hold down the rotor current to the value demanded by the torque of the external load.

The operation may be viewed in another manner if it is considered that, at speeds below synchronism, the frequency of the converter is subtracted from that of the main motor, resulting in a slip of the rotor below synchronism. Above synchronism the converter reverses its phase relations and causes the slip to become negative, so that the speed increases. There is a small range of speed very close to the synchronous value at which the rotary converter stands still and the main motor operates as a simple wound rotor motor with secondary resistance corresponding to that of the secondary circuit through the converter and intermediate

connections. This occurs while the voltage of the d.c. unit is nil, while the converter is at rest and when the direct voltage is being built up in either direction, d.c. is delivered to the slip rings of the main motor since the converter does not convert while at rest. At this instant the main motor acts as a synchronous motor and comes up to exact synchronism.

Over a range of about four per cent above and below synchronism the operation of the set is unstable and the torque developed is but a fraction of full load value.

We have considered the relations of the voltages and the currents in the various circuits but have not studied the interchanges of power between the various machines. When the main motor is running below synchronism the rotor currents flow in opposition to the counter voltage impressed from the converter. They therefore represent negative power input, or power output. Slip energy, wasted in resistance with rheostatic control, is thus transferred to the converter. It is here changed to d.c. and transmitted to the d.c. unit which converts it to mechanical power. The speed of the motor generator set is thus raised so that the a.c. unit operates above synchronism (if of the induction type) and delivers energy to the supply circuit. The slip energy of the main motor is partially wasted in the losses of its secondary circuit but most of it passes through the auxiliary machines and is returned to the supply lines.

When the set is operating above synchronism the a.c. unit of the motor generator set operates as a motor. The d.c. unit runs as a generator and delivers, through the converter, the energy which enables the main motor to run above synchronism. The proportion of the energy supplied through the auxiliary equipment depends upon the margin of operating speed above synchronous speed. The amount of energy received by the auxiliary equipment from the main motor operating below synchronism, depends upon the slip.

It will be seen that this system is a constant torque proposition. Below synchronous speed a given input to the main motor is partially converted to mechanical power and partially returned to the supply lines. At approximately synchronous speed, most of the input is converted to mechanical power, the losses alone being deducted. Above synchronous speed the auxiliary equipment aids in driving the main motor shaft. The mechanical horsepower output thus varies approximately directly with the speed.

The apparatus used for a dynamic control installation as above described is practically all standard equipment. The main motor is of the ordinary wound rotor type. It is possible to furnish auxiliary equipment to provide dynamic control for any ordinary wound rotor motor. The rotor converter is commonly a standard machine wound with the same number of phases as the secondary of the main motor. It is usually advisable, particularly in the larger sizes, to have the main motor rotor wound six phase with six slip rings. This gives a more economical converter design and better distributes the heating in the converter armature. The frequency and voltage rating must be consistent with the values obtained from the secondary of the main motor under operating conditions. A 25-cycle converter will often apply for use in connection with a 60-cycle main motor. The capacity of the converter is determined by the secondary current rating which is the same at all speeds. The size of the motor generator set depends on the speed range desired. For a range

of speed 30 per cent above and below synchronism the horse power capacity of the motor generator will be about 30 per cent of that of the main motor. Since this set may operate at any rotation, a high speed is used to reduce its cost. The direct current unit is an ordinary d.c. motor. Its shunt field is separately excited from the same circuit as that exciting the converter. In some cases it is found desirable to furnish a compound winding for the d.c. unit. Increase of load on the main motor increases the load on the auxiliary equipment. This increase causes a strengthening of the series field

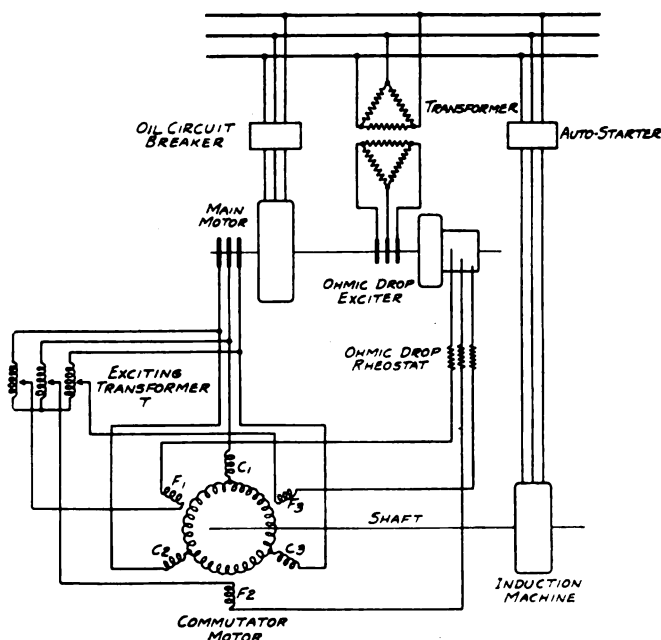


FIG. 10—Dgm. simplified diagram of connections of double range Scherbius set.

excitation of the d.c. unit and causes the main motor to slow down. The speed regulation of the main motor may be varied by adjusting the series field of the d.c. unit. The a.c. unit of the motor generator set may be either a synchronous or an induction motor. The induction machine is simpler and is commonly used.

The rotary converter d.c. motor type of dynamic control is similar to the previously explained system with the exception that the motor generator set, returning slip energy to the supply system, is replaced by a d.c. motor mounted on the common shaft with the main motor. Fig. 9 shows the layout and main connections of this system. The d.c. motor converts the slip energy into mechanical power at the main shaft. The operation and speed adjustment is similar to that of the converter motor generator system. To obtain a drooping speed characteristic the d.c. motor must be equipped with a comparatively strong series field. In the motor generator system the speed of the d.c. unit was approximately constant. In this second system the d.c. motor speed drops as the main motor slows down. In order to maintain the counter voltage at the slip rings the excitation of the d.c. machine must be correspondingly increased. It will be seen that this system of dynamic control is essentially a constant horse power proposition. The total input, minus the losses, is converted into mechanical power at the main shaft. Near synchronous speed the main motor delivers most of its input at the shaft. At reduced speeds the d.c. motor adds its torque to that of the main motor. At speeds above synchronism the torque of the d.c. unit opposes

that of the main motor. The net torque thus varies with the speed, giving a constant horse power characteristic.

The d.c. motor system of dynamic control is, in general, more costly than the motor generator system. The main motor is usually a large, slow speed machine. Since the d.c. motor is preferably mounted on a common shaft with the main motor, it runs at comparatively low speed and is therefore large for its rated output. The relative capacity of the d.c. machine depends, as in the previous system, upon the speed range to be covered. This machine must handle its maximum output at its minimum speed, however, thus requiring a relatively large frame. It is of particular advantage with this type of set that the main motor speed be as high as feasible since the cost of the auxiliary d.c. motor is so largely affected, as well as the main motor.

The Kramer system is particularly adapted for use on 60-cycle circuits where a standard 25-cycle converter can be utilized. It enjoys some special advantages for wide speed ranges. It is generally used for the larger installations involving auxiliary equipment of 1,000 hp. capacity and upwards. The fact that standard apparatus is employed and simple connections used, is a favorable factor. The constant hp. type of drive is of advantage where the load is such as to involve heavier torques at low than at high speed.

The Scherbius System.

The Scherbius system of induction motor speed control resembles the Kramer system in that it functions by introducing into the secondary circuit of a main wound rotor motor a counter-voltage which is subject to adjustment. The auxiliary equipment used to supply this counter-voltage comprises mainly a so-called three phase compensated commutator motor which is, in many respects similar to a d.c. motor. This commutator motor is mounted on a common shaft with a squirrel cage induction motor of perhaps 25 per cent. of the capacity of the main motor.

There are several type of three phase regulating motors, depending upon the characteristics desired. The type most commonly used in the "Double Range Scherbius System" will be briefly described and the functioning of the system outlined.

There is shown in Fig. 10 a simplified diagram of connections of a double range Scherbius set. Here it will be noted that the slip rings of the main motor are connected to the brushes of the commutator motor. This commutator motor must evidently develop a voltage having the same frequency as the secondary voltage of the main motor. This is the case. The stator of the commutator motor carries field windings F_1 , F_2 , F_3 . These fields are excited by current at slip frequency. The armature of the commutator motor is driven at practically constant speed by the induction motor on the common shaft. Thus the voltage generated in the commutator motor and taken off at its brushes is of frequency determined by the field excitation, that is, slip frequency. If the slip of the main motor increases or decreases, the frequency of the commutator motor automatically adapts itself to the changed conditions.

Since the rotation of the armature of the commutator motor is constant, the voltage generated is proportional to the flux set up by the F_1 , F_2 , F_3 . (The fields C_1 , C_2 , C_3 are compensating windings.) The flux set up in fields F_1 , F_2 , F_3 is proportional to the current passed through these windings. It will be noted that

these fields are excited, in part, from a transformer which is subjected to the secondary voltage of the main motor. Thus, as the slip and secondary voltage of the main motor increases, the voltage impressed on field windings F_1 , F_2 , F_3 increases directly. This would apparently tend to increase the strength of these fields. This tendency is offset however by the counter-voltage induced in these fields due to the fact that their flux is alternating. This counter-voltage is proportional to the field flux and also to the field frequency (slip frequency). Any increase in slip thus increases the counter-voltage in the field windings and maintains the field current and flux at a fixed value. Thus, the commutator motor tends to generate at its brushes, a constant voltage at slip frequency. This voltage being impressed at the slip rings of the main motor simply requires that motor to develop an excess of slip voltage sufficient to overcome this opposition in addition to the resistance drop due to secondary load current.

To change the speed of the main motor, the armature voltage of the commutator must be changed. This can be done by changing the strength of the fields F_1 , F_2 , F_3 . This is done by increasing the voltage impressed on these windings by connecting these windings to different taps of the transformer T. For each tap point there will result a definite field strength which will cause the commutator motor to develop a definite voltage in opposition to the slip voltage of the main motor, thus adjusting the speed of the latter.

When the main motor is operating near synchronous speed, its secondary voltage is very small, hence the voltage across transformer T is small and the excitation of fields F_1 , F_2 , F_3 approaches zero. A motor functioning purely as above described evidently could not operate at synchronous speed.

In order that the Scherbius set may be made to operate through synchronous speed an additional unit, called an "ohmic drop exciter" is provided. This is in reality a small frequency converter. It is mounted on the shaft of the main motor so that its speed is always the same as that of the main motor.

This machine consists of an armature like that of a rotary converter, having both commutator and slip rings. The field punchings which encircle the armature, are without windings. The commutator is provided with brushes in multiples of three in order to deliver three phase current. The slip rings are connected through a transformer to the main power lines. If voltage be applied to these slip rings while the armature is at rest, the alternating currents in the various coils produce a magnetic field which revolves around the rotor at a speed, depending upon the impressed frequency and inversely upon the number of poles in the armature winding just as in the ordinary induction motor. If the armature be rotated at synchronous speed in a direction opposite to the phase rotation of the revolving field, the resultant magnetic field does not actually rotate but stands still in space. The armature conductors, revolving at synchronous speed, cut this stationary flux and have generated in them a voltage which causes the delivery of d.c. at the brushes, just as in a d.c. generator. The voltage delivered at the brushes is proportionate to that impressed at the slip rings, just as in a rotary converter.

If the armature of the ohmic drop exciter be rotated in the same direction as before, but at a lesser speed, say two thirds synchronous speed, then the resultant field is not stationary. The armature is rotated forward

at $2/3$ synchronous speed. The revolving field produced by the armature rotates backward at synchronous speed. The resultant field then rotates backward at $1/3$ synchronous speed. The voltage appearing at the stationary brushes is thus alternating and its frequency is $1/3$ that of the circuit impressed at the slip rings. The voltage delivered at the brushes maintains a fixed ratio to that impressed at the slip rings and is thus constant, regardless of the speed. This will be evident if it is considered that the field, which is set up

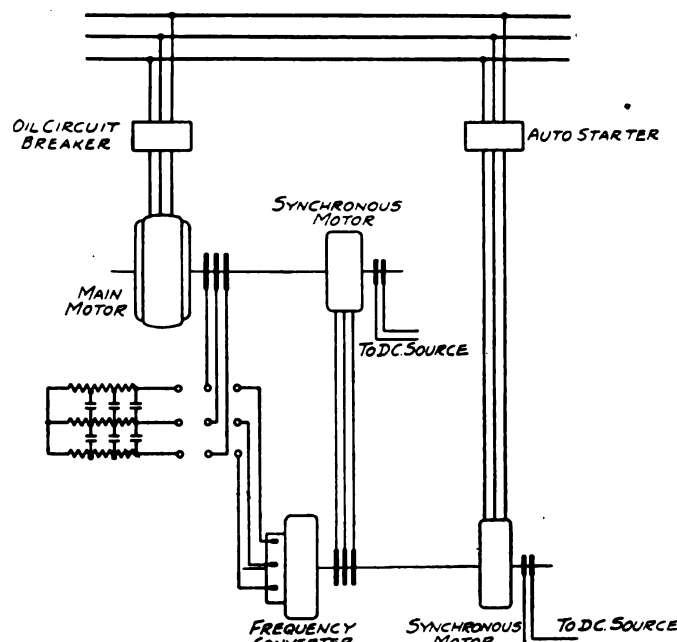


FIG. 11—Dgm. principal connections for frequency converter system of speed control, constant torque type.

by the armature, always rotates at the same speed with respect to the armature. The armature conductors thus cut the same flux and have generated in them the same voltage regardless of the rate of mechanical rotation.

If the armature of the ohmic drop exciter be rotated in the same direction as before, namely, opposite to the field rotation, and if the speed of rotation be greater than synchronous speed, then the resultant field will rotate in space in the same direction as the mechanical rotation and at a speed proportional to the marginal speed above synchronism. The voltage generated in the armature will have a phase rotation reverse to that when operating below synchronism.

To summarize, the ohmic drop exciter produces voltage of constant value, at slip frequency, and whose phase rotation changes as the speed of the excited passes through synchronous speed, at which point d.c. is produced.

Returning to the diagram in Fig. 10 we note that the ohmic drop exciter is so connected that it can supply exciting current to the fields F_1 , F_2 , F_3 . It is utilized for this purpose. A resistance is inserted in the circuit and this is so manipulated that the resistance drop in the fields plus the rheostat is always equal to the voltage generated by the exciter. The exciter is thus made to supply just enough excitation voltage at the fields to overcome the resistance drop in the latter at all times and with differing values of field current.

When the main motor is operating at a speed wide from synchronism, that is, with large slip, the counter-voltage across the field windings F_1 , F_2 , F_3 is nearly all

induced voltage and the resistance drop is relatively small so that the ohmic drop exciter has little influence. As the speed of the main motor approaches synchronism, the induced voltage across F_1 , F_2 , F_3 is reduced and the resistance drop becomes proportionately greater.

At synchronous speed the ohmic drop exciter produces direct current which, flowing in fields F_1 , F_2 , F_3 sets up a fixed field and causes a direct voltage to be generated in the armature of the commutator motor. As a result of this voltage, d.c. flows in the secondary of the main motor and causes this unit to function in a manner similar to a synchronous motor.

An increase in field strength of F_1 , F_2 , F_3 then causes the voltage of the latter to increase, causing an increased current flow through the rotor of the main motor, increasing the torque of the latter and causing it to increase its speed above synchronism. The set then operates in a manner similar to its operation below low synchronism except that the phase rotation of the main motor secondary, the ohmic drop exciter, the fields F_1 , F_2 , F_3 and the commutator motor are all automatically reversed.

When operating below synchronism the polyphase commutator motor receives slip energy from the main motor secondary. It drives the induction unit of its set at a speed slightly above synchronism, causing the latter to function as an induction generator delivering electrical energy to the main supply system. Thus the slip energy of the main motor, less the losses in the auxiliary machines, is returned to the power system.

When operating above synchronism conditions are reversed. The induction unit of the auxiliary set acts as a motor, taking electric power from the supply system and driving the polyphase commutator motor. The latter delivers electric energy to the secondary of the main motor, which converts it into mechanical power.

Power Factor.

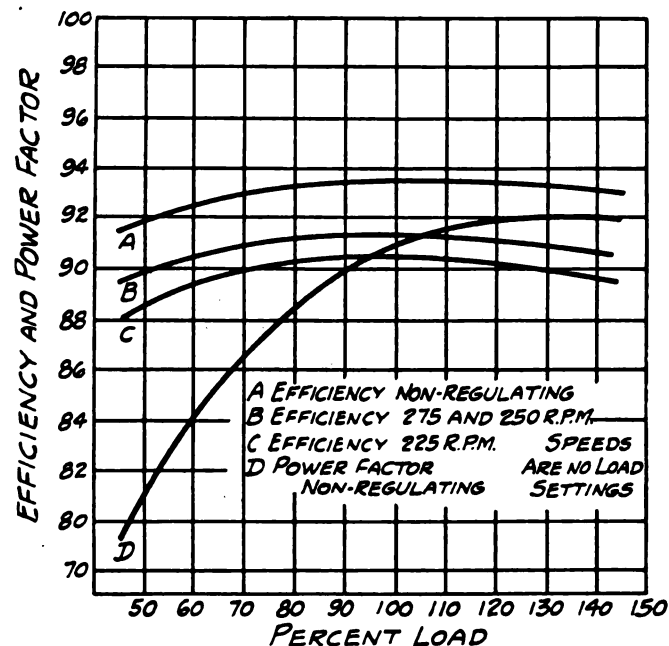
Several means are commercially employed to maintain a good power factor for the set. Power factor may be improved by certain adjustments of the exciting transformer which changes the phase of the exciting current. Adjustment of the voltage of the ohmic drop exciter and ohmic drop rheostat, in conjunction with the above, permit adjusting the power factor at various speeds. An out of phase component of exciting current may be obtained at speed near synchronism by means of taps to the fields of the regulating motor from the ohmic drop exciter. By these means a power factor of 95 per cent or better may be maintained over a range of speeds and loads.

Performance.

The Scherbius system is essentially a constant torque equipment. At reduced speeds the slip energy is deducted from main motor input and returned to the power system. At speeds above synchronism electrical power is introduced into both stator and rotor of the main motor, increasing its hp. capacity. A constant hp. drive may be obtained by mounting the commutator motor on the common shaft with the main motor but this is not ordinarily commercially feasible.

The double range Scherbius system enjoys an advantage in that the synchronous speed is intermediate in the operating range. The size of the auxiliary set is determined largely by the amount of slip energy handled which, in turn depends upon the slip. Thus with a double range equipment the auxiliary set is only

about half the size necessary with an equivalent single range equipment. Another advantage accrues from the fact that the motor may be operated at an intermediate speed as a simple induction motor. The use of an independent auxiliary set permits of standardized designs and high speeds, factors minimizing first cost.



NOTE
POWER FACTOR, REGULATING, RANGES
BETWEEN 95 AND 100 PERCENT

FIG. 12—Dgm. efficiency and power factor curves for Scherbius set.

The Scherbius system is at its best on 25 cycle systems and for moderate speed ranges.

Frequency Converter System.

Methods.

The frequency converter system of speed control resembles the Kramer and the Scherbius systems in that a counter-voltage at slip frequency is introduced into the secondary circuit of the main motor and this voltage is varied to change the speed. There are two methods of application, one giving a constant torque capacity, the other affording constant hp.

Both of these systems employ a frequency converter which is similar in principle to the ohmic drop exciter used in the Scherbius system. This unit is used however to convert the frequency of the slip energy of the main motor, rather than serving as an exciter.

In the constant torque system the frequency converter is mounted on the common shaft with the main motor. It is wound for the same number of poles. The brushes may be located so as to supply either 3-phase or 6-phase current. The collector rings of the frequency converter unit are connected to the main power supply system through a transformer or regulator arranged to vary the voltage supplied to the converter. At the brushes of the converter may be taken off 3-phase or 6-phase voltage as desired, according to the brush arrangement. The frequency of this voltage is proportional to the difference between the frequency applied at the collector rings and the frequency of mechanical rotation. The voltage taken off at the commutator is proportional to that impressed at the collector rings. In these features the performance of this

converter duplicates the action of the ohmic drop exciter.

As above stated, the frequency converter supplies an adjustable voltage at a frequency proportional to the slip. This frequency is the same as the slip frequency of the main motor since the primary of the main motor and the collector rings of the frequency converter are both supplied from the same system, both machines are wound with the same number of poles and both are mounted on the same shaft and must rotate together. Therefore the voltage produced at the brushes of the frequency converter is suitable for introduction at the slip rings of the main motor to serve as an adjustable counter-voltage. Fig. 11 shows the principal connections for this system which are seen to be quite simple.

With this arrangement the slip energy of the main motor is converted in frequency and returned to the supply system. When running above synchronism the reverse is true as power is there taken from the supply system by the frequency converter and furnished to the rotor of the main motor. At about synchronous speed the converter supplies d.c. at the slip rings of the main motor. It should be evident that this drive has a greater hp. capacity at high speeds than at low speeds. At speeds below synchronism, but a portion of the input is converted to mechanical power. At speeds above synchronism both the stator and rotor input are converted to useful work. The converter unit produces no torque.

Equipments providing a constant hp. are more frequently desired than those producing constant torque capacity. Moreover, the set above described is at a disadvantage in that a special type of frequency converter must be supplied having a speed corresponding to that of the main motor which is usually a rather low speed unit. For these reasons the constant hp. system has points of vantage.

In the constant hp. arrangement the frequency converter unit is separately driven at constant speed by a small synchronous motor which supplies the losses of the unit. Another synchronous machine is mounted on the common shaft with the main motor. The last named machine is made to produce an adjustable voltage by controlling its excitation. The frequency of this voltage is proportional to its slip. This variable voltage at variable frequency is impressed at the collector rings of the frequency converter which is driven at constant speed. The frequency taken off at the brushes of this unit is proportional to the difference between the speed of rotation and the frequency impressed on the collector rings. It is thus proportional to the slip of the main motor. We then have an adjustable voltage at slip frequency which serves as a counter-voltage when applied at the slip rings of the main motor. A motor unit, with wound rotor and synchronous motors mounted on a common shaft.

In this arrangement the slip energy of the main motor is simply converted by the frequency converter and introduced into the synchronous machine of the main set where it is converted to mechanical power. When operating above synchronism the synchronous machine is a generator supplying electrical energy to the rotor of the main motor through the frequency converter. In either case the input to the main motor, less the losses, is converted to mechanical power at the common shaft. As the permissible input is a limiting factor, approximately the same hp. is available at all speeds.

As already intimated, both of the frequency con-

verter systems above described permit operation under full load both above and below synchronism and also at synchronism. They thus duplicate the performance and enjoy much the same advantages as the Scherbius system in this regard.

It is possible to correct the power factor of the main induction motor of a set of this type by causing the voltage supplied by the frequency converter to be somewhat out of phase with the secondary voltage of the main motor. This may be accomplished by shifting the brushes of the frequency converter. To maintain a constant power factor, the extent of brush shift required varies at different speeds. In order to avoid the necessity of actually shifting the brushes the equivalent effect can be obtained with the constant hp. set by shifting the center line of the field poles on the synchronous motor driving the frequency converter. This is done by governing the exciting in the different sections of distributed field windings.

Dynamic Control Characteristics.

In general, dynamic control is applicable to large units only because of the amount of auxiliary equipment required. For small units it is more simple to convert to d.c. and provide adjustable speed motors. Very large units involve power in quantities too large to permit of easy conversion, transmission or distribution as d.c. at low voltage.

The operation of dynamic control sets is not complicated. The initial cost is necessarily high because of the number of units involved. The speed-torque characteristics obtainable are parallel to those obtained from d.c. adjustable speed shunt motors. The pull out torque when operating with auxiliaries is usually greater than two times full load torque and is thus comparable to operation on resistance. Since the motor starts as a wound rotor motor on resistance the starting conditions are satisfactory. The efficiency is much higher than obtainable with rheostatic control due to the utilization of slip energy but, due to losses in the auxiliary units, the efficiency is lower at speeds wide from synchronism. It is possible to correct the power factor with any of the dynamic control methods but this is feasible only to a limited extent. The power factor of the set therefore depends largely upon that of the main motor and is lowest with slow speed, 60-cycle motors. Fig. 12 gives curves showing the efficiency and power factor of a Scherbius set over a range of conditions. The performance shown is quite typical of dynamic control sets in general.

Dynamic control is the only method yet devised for securing satisfactory adjustment constant speed characteristics from a.c. motors. These sets have been applied quite extensively for main roll drives in steel mills. They have also found some applications on mine fans and elsewhere. It should perhaps be noted that they are not adapted where rapid changes in speed are required but are restricted to fairly constant running, adjustable speed service.

DRY WINTER WEAKENS JAPAN'S ELECTRIC POWER

Steam power plant equipment should find a good market in Japan at the present time, since hydro-electric companies have awakened to the fact that their present systems are sometimes inadequate to meet the demand without auxiliary steam power stations, says the Industrial Machinery Division of the Department of Commerce.

Short Method for Figuring Alloys

A Comprehensive System of Tables and Proportions Used
by Practical Steel Makers.

By J. M. QUINN*

MODERN steel making has been strongly influenced by the development of various alloys. Specifications are carefully drawn, and deliveries are carefully inspected under a variety of checks. Buyers demand not simply steel, but specific steels; strength, ductility, toughness, durability, lightness, color, hardness, surface, cheapness, conductivity, corrosion-resistance, all must be considered.

Steel-making has been reduced to formulae procedure; the following data is an assembly of known values, reduced from practice which may be used as a ready reference guide in compressed form.

Short Methods for Figuring Ferro Alloy Additions to All Metal Charges Taking Into Consideration the Increased Metal Weight Resulting From Alloy Additions.

Formula for a single alloy addition where the major alloy in the initial charge will not affect the final analysis materially:

- (1) (Pounds of Ferro Alloy to be added = Weight of Metal $\times$ (Factor "A" at percentage desired and at per cent Ferro Alloy used)

Formula for one or more alloy additions where the major alloys in the initial charge will affect the final analysis materially:

- (2) (Pounds of Ferro Alloy to be added = Weight of Metal $\times$ (Factor "A" at percentage desired and at per cent Ferro Alloy used — per cent alloy in metal)

Formula for additional commodities in the Ferro Alloy where only one alloy is added to the metal and where the metal contains none or only small percentage of these commodities:

- (3) (Per cent commodity will raise metal bath) = (Per cent commodity in Ferro Alloy) $\times$ (Factor "B" at the corresponding factor "A" used)

Formula for additional commodities in the Ferro Alloy where only one alloy is added to the metal and where the metal contains large amounts of these commodities or in such percentages that their effectiveness should be considered in conjunction with the alloy addition:

- (4) (Per cent commodity will raise metal bath) = (Per cent commodity in Ferro Alloy — Per cent commodity in metal) $\times$ (Factor "B" at corresponding factor "A" used)

It should be kept in mind that while the various metal weights multiplied by factor "A" giving different weights of alloy to be added, the proposition of

the other commodities in the ferro alloy multiplied by the corresponding factor "B" remains constant. To illustrate factor "A" at 12 per cent desired and 80. per cent alloy is .1765 and is multiplied by any weight to obtain the pounds of 80. per cent Ferro alloy required to raise metal bath 12. per cent from zero. However, additional commodities in this percentage alloy, say 6. per cent Carbon multiplied by the corresponding Factor "B" .1500, giving .90 per cent Carbon, will raise a 100 pound metal bath 90 points or a 10,000 pounds bath 90 points from zero.

Factors "A" and "B" on the following pages were calculated as follows:

$$(5) \frac{\% \text{ Alloy Desired in Metal}}{\% \text{ Ferro Alloy} - \% \text{ Alloy Desired in Metal}} = \text{Factor "A"}$$

$$(6) \frac{\% \text{ Alloy Desired in Metal}}{\% \text{ Ferro Alloy}} = \text{Factor "B"}$$

Example using 80. per cent Ferro Alloy and 12. per cent desired in metal:

$$\text{Factor A} = \frac{12}{80-12} = \frac{12}{68} = .1765$$

$$\text{Factor B} = \frac{12}{80} = .1500$$

In the following examples no metal or alloy losses or gains were considered as each type furnace has its own varying practice.

Example for a single alloy addition where the major alloy in the initial charge will not affect the final analysis materially using formulas (1) and (3).

Making Manganese Steel from Ordinary Soft Steel Scrap—(Refer to Table 1).

Assume 2000 lbs. charge of ordinary steel scrap in electric furnace. Preliminary test taken just before removing oxidizing slag. Assume analysis of Ferro Manganese is 80. per cent Mn., 6. per cent C., .16 per cent P., .4 per cent Si.

Then the required addition of 80 per cent Ferro Manganese for a final 12.00 per cent Mn. in the steel is calculated as follows using Formula (1) (Factor "A" at 12.00 per cent desired at 80. per cent alloy is .1765).

$$2000 \text{ lbs.} \times .1765 = 353 \text{ lbs. Ferro Manganese}$$

Now as the final analysis of the metal will be changed materially by the commodities contained in this Ferro Manganese, their respective effectiveness is readily obtained using Formula (3) (Factor "B" at corresponding Factor "A" is .1500).

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$$\begin{aligned}
 6\% \times .1500 &= .90 \% \text{ Carbon} \\
 &\quad (\text{usually called 90 points}) \\
 .16\% \times .1500 &= .024\% \text{ Phosphorus} \\
 .4\% \times .1500 &= .06\% \text{ Silicon}
 \end{aligned}$$

We can now conclude that 353 lbs. of this 80 per cent Ferro Manganese added to the 2000 lbs. of steel will increase the several elements in the metal, very close to the desired analysis, and only a small addition of Ferro Silicon will be necessary to shape up the metal. If there are no losses or gains the approximate final analysis will be 1.00 per cent Carbon, 12.10 per cent Manganese, about .20 per cent Silicon, .054 per cent Phosphorus, about .030 per cent Sulphur and the final metal weight 2353 lbs.

Example for a single alloy addition where the major alloy in the initial charge will affect the final analysis materially, using Formulas (2) and (4).

Making Manganese Steel from Manganese Steel Scrap—(Refer to Table 2).

Assume 2000 lbs. charge of Manganese steel scrap in electric furnace. Preliminary test taken after first slag has been made reducing and the greater proportion of the Manganese in the slag reduced in the metal bath. Assume analysis of Ferro Manganese used is the same as in the previous example.

Then the required addition of 80 per cent Ferro Manganese for a final 12.00 per cent Manganese in the steel is calculated as follows using Formula (2) (Factor "A" at 4.00 per cent desired at 80. per cent alloy — 8. per cent in metal) or (Factor "A" at 4.00 per cent desired at 72. per cent alloy is .05882.)

$$2000 \text{ lbs.} \times .05882 = 118 \text{ lbs. Ferro Manganese}$$

Now as the initial metal bath already contains 8.00 per cent Manganese and the 80 per cent alloy used in this case is considered to be 72 per cent alloy and in all cases where Factor "A" is used for a single alloy

addition, the corresponding Factor "B" can also be used for the other commodities contained in the ferro alloy. Using Formula (4) (Factor "B" at corresponding Factor "A" is .05555).

It will be noted that the metal bath contains large per centages of Carbon, Silicon, and Phosphorus and these commodities should be deduced from the respective commodity in the Ferro alloy, where accurate calculations are required, when using Formula (4).

$$\begin{aligned}
 6.00\% - .87\% &= 5.13\% \\
 5.13\% \times .05555 &= .28\% \text{ Carbon} \\
 .40\% - .20\% &= .20\% \\
 .20\% \times .05555 &= .01\% \text{ Silicon} \\
 .16\% - .05\% &= .11\% \\
 .11\% \times .05555 &= .006\% \text{ phosphorus}
 \end{aligned}$$

In this case the Silicon and Phosphorus in the Ferro Manganese affected the bath so slightly that they should be disregarded and are only included here to illustrate the calculations.

We can now conclude that 118 lbs. of .80 per cent Ferro Manganese added to this 2000 lbs. of remelted manganese steel will increase the metal to within the specification. The approximate final analysis will be 1.15 per cent Carbon, 12.00 per cent Manganese, .21 per cent Silicon, .056 per cent Phosphorus, about .030 per cent Sulphur and the final weight 2118 lbs.

Example for more than one alloy addition where the major alloys in the initial charge will affect the final analysis material using Formula (2).

Making High Speed Steel from High Speed Steel Scrap and Swedish Iron—(Refer to Table 3).

Assume 10,000 lbs. charge of high speed steel scrap and Swedish iron in electric furnace. Preliminary test taken after first slag has been made reducing and the

TABLE 1—MANGANESE STEEL FROM SOFT STEEL SCRAP

	Carbon	Manganese	Silicon	Phosphorus	Sulphur
Specification	1.00/1.20%	11.00/13.00%	under .30%	under .06%	under .05%
Preliminary test reported.....	.10%	about .10%	about .05%	about .03%	
Per cent bath to be raised.....		12.00%			

TABLE 2—MANGANESE STEEL FROM MANGANESE SCRAP

	Carbon	Manganese	Silicon	Phosphorus	Sulphur
Specification	1.00/1.20%	11.00/13.00%	under .30%	under .06%	under .05%
Preliminary test reported.....	.87%	8.00%	about .20%	about .05%	
Per cent bath to be raised.....		4.00%			

TABLE 3—HIGH SPEED STEEL FROM H. S. STEEL SCRAP AND SWEDISH IRON

	W	Cr	Va	Mn	C	Si
80% Ferro Tungsten	80.25%				.09%	
70% Ferro Chromium		70.15%			5.90%	
39% Ferro Vanadium			39.30%		.20%	1.92%
80% Ferro Manganese				80.30%	6.00%	.40%
50% Ferro Silicon						50.00%
Specification in Part.....	{17.50%	3.75%	1.35%	.20%	.60%	.15%
	{18.50%	4.25%	1.65%	.30%	.70%	.25%
Preliminary Analysis.....	13.00%	3.00%	1.00%	.10%	.55%	about .05%
Per cent bath to be raised...	5.00%	1.00%	.50%	.15%	.10%	.15%

greater proportion of the major alloys reduced from the slag to the metal bath.

One method to show how these alloy additions are calculated is to make columns for the three major alloys and show the calculations by operations taking largest additions first.

First Operation.

As the bath already contains 13.00 per cent W and 5.00 per cent additional is desired, then 10,000 lbs. $\times$ Factor "A" at 5.00 per cent desired and 67. per cent alloy is $.08064 = 806$ lbs. Ferro Tungsten required. This first operation shortened to actual figures would be: 10,000 lbs. $\times$ $.0806 = 806$ lbs. Ferro W.

Second Operation.

As the bath already contains 3.00 per cent Cr and 1.00 per cent additional is desired, then 10,000 lbs. $\times$ Factor "A" at 1.00 per cent desired and 67. per cent alloy is $.01515 = 151$ lbs. Ferro Cr. Now the 806 lbs. W calculated on the first operation must also contain 4.00 per cent Cr. Therefore, 806 lbs. $\times$ Factor "A" at 400 per cent desired at 70 per cent alloy is $.06061 = 49$ lbs. Ferro Cr.

Third Operation.

As the bath already contains 1.00 per cent Va. and .50 per cent additional is desired, then 10,000 lbs. $\times$ Factor "A" at .50 per cent desired and 38 per cent alloy is $.01333 = 133$ lbs. Ferro Vanadium. Now the 806 lbs. W and 200 lbs. Cr. calculated on the first and second operations must also contain 1.50 per cent Va. Therefore 1006 lbs. $\times$ Factor "A" at 1.50 per cent desired at 39 per cent alloy is $.0400 = 40$ lbs. Ferro Va.

Fourth Operation.

Now the 200 lbs. Cr. and 173 lbs. Va. calculated on the second and third operations must also contain 18.00 per cent W. Therefore 373 lbs. $\times$ Factor "A" at 18.00 per cent desired at 80. per cent alloy is $.2903 = 98$ lbs. Ferro Tungsten. Preliminary total Ferro Tungsten = 904 lbs.

Fifth Operation.

Now the 173 lbs. Va. and 98 lbs. W calculated on the third and fourth operations must also contain 4.00 per cent Cr. Therefore, 271 lbs. $\times$ $.06061 = 16$ lbs. Ferro Cr. Preliminary total Ferro Chrome = 216 lbs.

Sixth Operation.

Now the 98 lbs. W and 16 lbs. Cr. calculated on the fourth and fifth operations must also contain 1.50 per cent Va. Therefore, 114 lbs. $\times$ $.0400 = 5$ lbs. Ferro Va. = 178 lbs.

Seventh Operation.

The addition of .15 per cent of Manganese and .15 per cent Silicon to the metal will take 21 lbs. of Ferro Manganese and 36 lbs. Ferro Silicon. This 55 lbs. of ferro alloy will require 16 lbs. Ferro Tungsten, 4 lbs. Ferro Chrome and 3 lbs. of Ferro Vanadium. These amounts being calculated in a similar manner to the other alloy additions.

While the operations could be continued and the alloy additions calculated more accurately, it is the usual procedure because of the time element at the electric furnace, to add a few pounds more to each of the major alloys to take care of this figuring. In this case add 16 lbs. Ferro W, 4 lbs. Ferro Chrome and 2 lbs. Ferro Vanadium extra.

A summary of the Ferro Alloy Calculations is as follows:

	W	Cr	Va	Mn	Si
For Original Charge....	806	151	133		
For Ferro Cr and Va...	98				
For Ferro W and Va...		65			
For Ferro W and Cr...			45		
For Ch'ge. + W, Cr, Va.				21	34
For Ferro Mn and Si...	16	4	3		
For Quick Figuring ...	16	4	2		
Grand total Ferro Alloys	936	224	183	21	34

This 1398 lbs. of Ferro Alloys added to the original charge of 10,000 lbs. equals 11,398 lbs. total metal. By dividing this 11,398 lbs. into the pounds of pure alloys now contained in the metal you can check the above calculations and will find the desired percentages of Tungsten, Chrome, Vanadium, etc. in the final high speed steel.

For example—The original charge of 10,000 lbs. contained 13.00 per cent Tungsten.

10,000 lbs. $\times$ 13.00 per cent = 1300 lbs. of pure Tungsten.

The total 80 per cent Ferro Tungsten added is 936 lbs.

936 lbs. $\times$ 80. per cent = 748.8 lbs. pure Tungsten.

This total of 2048.8 lbs. of pure tungsten divided by the grand total metal charge of 11,398 lbs. equals 17.98 per cent tungsten in the final metal. The chromium, vanadium, manganese, and silicon are figured in the same manner.

Since more than one alloy has been added to this high speed steel and more than one "A" Factor used, the additional commodities contained in the ferro alloys cannot be calculated with formula 4 or Factor "B." A glance at the analysis of the ferro alloys shows that the carbon in the ferro chrome and silicon in the ferro vanadium are the only other commodities affecting the analysis materially. Their effectiveness is calculated as follows:

6.00 per cent carbon in 224 lbs. ferro chrome = 13 lbs. pure carbon. $13 \div 11,398 = 11$ per cent carbon in metal.

1.9 per cent silicon in 183 lbs. ferro Va. = 3.5 lbs. pure Sil. $3.5 \div 11,398 = .03$ per cent Sil. in metal.

The carbon in the ferro chrome will raise the metal bath .11 per cent and with the .55 per cent carbon already in the metal as shown by the preliminary test the final analysis will be .66 per cent carbon. The .03 per cent silicon obtained from the vanadium will effect the final silicon in the metal very slightly and may be disregarded.

As a matter of general interest let us calculate part of the same alloy additions for this high speed heat by the usual method and we can then appreciate the value of the Table of Factors.

The formula for calculating these additions is as follows:

(7) (Pounds of ferro alloy to be added = [(Weight of metal) $\times$ (Per cent metal to be raised)] $\div$ [(Per cent ferro alloy used) — (Percentage desired in final metal)])

First Operation.

As the bath already contains 13 per cent W and 5.00 per cent additional is desired, then $(10,000 \times 5.00$

per cent) divided by (80 per cent alloy minus 18 per cent desired in final metal) = 806 lbs. ferro tungsten.

This first operation shortened to actual figures would be:

$$\frac{10,000 \text{ lbs.} \times 5.00}{80-18} = \frac{50000 \text{ lbs.}}{62} = 806 \text{ lbs. Ferro W.}$$

Second Operation.

As the bath already contains 3.00 per cent Cr. and 1.00 per cent additional is desired, then (10,000 lbs. $\times$ 1.00 per cent) divided by (70 per cent alloy minus 4 per cent desired in final metal) = 151 lbs. ferro chrome. Now the 806 lbs. W calculated on the first operation must also contain 4.00 per cent Cr. Therefore, (806 lbs. $\times$ 4.00 per cent) divided by (70 per cent alloy minus 4 per cent desired in the final metal) = 49 lbs. ferro chrome.

Third Operation.

As the bath already contains 1.00 per cent Va. and .50 per cent additional is desired then (10,000 lbs. $\times$.05 per cent) divided by (39 per cent alloy minus 1.50 per cent desired in final metal) = 133 lbs. ferro vanadium. Now the 806 lbs. W and 200 lbs. Cr. calculated on the first and second operations must also contain 1.50 per cent Va. Therefore, (1006 lbs. $\times$ 1.50 per cent) divided by (39 per cent alloy minus 1.50 per cent desired in final metal) = 40 lbs. ferro vanadium.

Fourth Operation.

Now the 200 lbs. and 173 lbs. Va. calculated on the second and third operations must also contain 18.00 per cent W. Therefore (373 lbs. $\times$ 18.00 per cent) divided by (.80 per cent alloy minus 18 per cent) = 98 lbs. ferro tungsten. Preliminary total tungsten = 904 lbs.

Fifth Operation.

Now the 173 lbs. Va. and 98 lbs. W calculated on the third and fourth operations must also contain 4.00 per cent Cr. Therefore (271 lbs. $\times$ 4.00 per cent) divided by (70 per cent alloy minus 4 per cent desired) = 16 lbs. ferro chrome. Preliminary total ferro chrome = 21 lbs.

Sixth Operation.

Now the 98 lbs. and 16 lbs. Cr. calculated on the fourth and fifth operations must also contain 1.50 per cent Va. Therefore (114 lbs. $\times$ 1.50 per cent) divided by (39 per cent alloy minus 1.50 per cent desired) = 5 lbs. ferro vanadium. Preliminary total ferro Va. = 178 lbs.

Comparing the usual and the short method of figuring alloy additions, it is readily apparent that long division is eliminated in the short method. In the calculation with the short method note that the factor used in the second section of the third operation is also used in the second section of the third operation is also the long method each section of all operations has to

be calculated separately, taking a considerably longer time.

Short Method for Figuring Ferro Alloy Additions To All Metal Charges Where the Increased Metal Weight Resulting from the Alloy Additions Is Not Taken Into Consideration. This Method Only Recommended Where Accurate Calculations Are Not Required or Where Allowance Is Made for the Increased Metal Weight.

Formula for one or more alloy additions with or without alloys in the initial charge.

$$(8) \quad (\text{Pounds of Ferro Alloy to be added}) = \frac{\text{Weight of Metal} \times (\text{Factor "B" at Percentage Desired and at Percentage Ferro Alloy used.})}{\text{Factor "B" at Percentage Desired and at Percentage Ferro Alloy used.}}$$

Formula for additional commodities in the ferro alloy where one or more alloy is added to metal, with or without alloys in the initial charge.

$$(9) \quad (\text{Percent commodity will raise metal bath}) = \frac{(\text{Per cent commodity in ferro alloy}) \times (\text{Factor "B" at percentage desired and at percentage ferro alloy used})}{\text{Factor "B" at percentage desired and at percentage ferro alloy used.}}$$

Formulas (8) and (9) are taken from formula (3) and are reworded to make the calculation more clear. In other words, the metal charges are multiplied by the desired "B" factors to find the alloy additions required and these same "B" factors are used to calculate the effectiveness of the other elements in the respective alloys. It is well to mention again that while the various metal weights multiplied by Factor "B" giving different weights of alloy to be added, the proportion of other commodities in the ferro alloy multiplied by Factor "B" remains constant.

Example for more than one alloy addition where major alloys are contained in the initial charge in small percentages. Using formulas (8) and (9).

Making Simple Steel for Castings—(Refer to Table 4).

Assume 2000 lbs. of ordinary steel scrap in electric furnace. Preliminary test taken just before removing oxidizing slag. Assume analysis of ferro manganese is .80 per cent Mn., 6. per cent C. and analysis of ferro silicon is 50. per cent Si.

	Carbon	Manganese	Silicon
Specification	.20/.30%	.80/1.00%	under .30%
Preliminary test reported	.10%	.10%	about .05%
Per cent bath to be raised		.90%	.25%

The required addition of 80 per cent ferro manganese is calculated on the high side using formula (8): (Factor "B" at .90 per cent desired and 80. per cent alloy is .01125) and formula (9) for the carbon in the ferro manganese.

$$2000 \text{ lbs.} \times .01125 = 22.56 \text{ lbs. ferro manganese.}$$

$$6.00 \text{ carbon} \times .01125 = .067 \text{ per cent carbon or } 6\frac{3}{4} \text{ points.}$$

TABLE 4—MAKING SIMPLE STEEL FOR CASTINGS

	C.	Mn.	Si.	Cr.	Il.
Specification	.20/.30%	.30/.60%	.10/.20%	1.25/1.75%	3.25/3.75%
Preliminary analysis	.10%	.10%	.05%	none	none
Per cent bath to be raised	.15%	.40%	.40%	1.50%	3.50%

The required addition of 50. per cent ferro silicon is calculated on the high side also using formula (8): (Factor "B" at .30 per cent desired and at 50. per cent alloy is .006)

$$2000 \text{ lbs.} \times .006 = 12 \text{ lbs. ferro silicon}$$

The object in calculating the alloy addition on the high side or limit of the specification is to take care of the increase metal weight caused by the alloy additions and still be within the specification range. This procedure is recommended where "B" factors are used in calculating alloy additions for simple steels. The 22.5 lbs. of 80 per cent ferro manganese contains 18 lbs. of pure manganese and dividing this by the total metal weight, 2035 lbs., you will obtain .88 per cent which is the actual percentage the metal bath was raised by the ferro manganese addition.

Now the metal bath will most always pick up five or more points of carbon from the reducing slag with carbon as a reducing agent and with the 6.7 points of carbon added with the ferro manganese, the final analysis will be within the specification.

At many steel plants the formula used for calculating alloy additions is as follows:

$$(10) \quad (\text{Pounds of ferro alloy to be added}) = \frac{(\text{Weight of metal}) \times (\text{Per cent metal to be raised})}{\text{Per cent ferro alloy used}}$$

Formula (8) was derived from this foregoing formula by dividing (Per cent metal to be raised) by (Per cent ferro alloy used) obtaining a factor which is multiplied by the metal weight.

When making alloy steels using formula (10) the calculator estimates the approximate weight of the alloys to be added to the original metal charge and then starts calculating with the increased metal weight as a basis. This estimation requires some experience to secure any degree of accuracy and is usually only attempted by those who are making the same classes of steels day after day. Consideration is taken of the total scrap charges, what the total alloy additions were on similar heats and how the preliminary analysis of the previous heats have been finishing.

We will take for example a heat of electric steel and compare the short and usual methods of calculating these additions.

Total Charge Estimated Before Any Calculations Are Made.

Original scrap charge	13000 lbs.
50% Ferro Silicon...	29 lbs.
80% Ferro Manganese	69 lbs. containing 6.00% C.
70% Ferro Chrome..	290 lbs. containing 5.90% C.
99% Nickel	512 lbs.

Est. total alloy and
scrap 13900 lbs.

SHORT METHOD

Using Formulas (8) and (9)

$$\begin{aligned} \text{Mn} &= 13900 \times .005 = 70 \text{ lbs. Ferro Mn.} \\ \text{Si} &= 13900 \times .0602 = 28 \text{ lbs. Ferro Si.} \\ \text{Cr} &= 13900 \times .021 = 292 \text{ lbs. Ferro Cr.} \\ \text{Ni} &= 13900 \times .037 = 514 \text{ lbs. Ni.} \end{aligned}$$

Now the carbon contained in the ferro manganese and chrome must be considered. This is readily ob-

tained by multiplying the percentage by the factor used for that alloy.

Carbon in ferro manganese:

$$6.00 \times .005 = .03\% \text{ carbon in metal is raised}$$

Carbon in ferro chrome:

$$5.90 \times .021 = .12\% \text{ carbon in metal is raised}$$

USUAL METHOD

Using Formula (10)

$$\text{Mn} = \frac{13900 \times .40}{80} = 70 \text{ lbs. Ferro Mn.}$$

$$\text{Si} = \frac{13900 \times .10}{50} = 28 \text{ lbs. Ferro Si.}$$

$$\text{Cr} = \frac{13900 \times 1.50}{70} = 292 \text{ lbs. Ferro Cr.}$$

$$\text{Ni} = \frac{13900 \times 3.50}{99} = 514 \text{ lbs. Ni.}$$

To find the effectiveness of the carbon contained in the ferro manganese and chrome, this must be reduced to pure carbon and divided by the total metal.

Carbon in ferro manganese:

$$70 \text{ lbs.} \times 6.00 = 4.2 \text{ lbs. pure carbon}$$

Carbon in ferro chrome:

$$292 \text{ lbs.} \times 5.90 = 17.2 \text{ lbs. pure carbon}$$

$$\text{Now } \frac{21.4}{13900} = .15\% \text{ carbon in metal is raised}$$

The foregoing procedure can be applied to all alloy additions where there are none or only small percentages of alloys contained in the original charge. However, when calculating alloy additions for a high speed steel heat or other steels containing large percentages of alloys, formulas (8) or (10) are applied somewhat differently. With steels of this type the pounds of alloys necessary to raise the original charge the required percentages from the amounts shown by the preliminary analysis are calculated and also the pounds of alloys necessary to raise the total alloy additions the required percentages from zero. Then the respective alloys calculated are added together.

To illustrate, let us calculate part of the alloy additions for the high speed steel heat given in Section "A." We will assume the calculator estimated 1400 lbs. of alloys necessary for the 10,000 scrap charge. For briefness we will use formula (8).

First Operation.

As the bath already contains 13.00 per cent W and 5.00 per cent additional is desired, then $10,000 \text{ lbs.} \times \text{Factor "B" at } 5.00 \text{ per cent desired and } 80 \text{ per cent alloy is } .0625 = 625 \text{ lbs. W.}$

Now the 1400 lbs. of alloys must also contain 18.00 per cent W. Therefore, $1400 \text{ lbs.} \times \text{Factor "B" at } 18.00 \text{ per cent desired at } 80 \text{ per cent alloy is } .225 = 315 \text{ lbs. W.}$

$$\text{Total ferro tungsten} = 940 \text{ lbs.}$$

Second Operation.

As the bath already contains 3.00 per cent Cr. and 1.00 per cent additional is desired, then $10,000 \text{ lbs.} \times \text{Factor "B" at } 1.00 \text{ per cent desired and } 70 \text{ per cent alloy is } .0143 = 143 \text{ lbs. chrome.}$

Now the 1400 lbs. of alloys must also contain 4.00 per cent Cr. Therefore, $1400 \text{ lbs.} \times \text{Factor "B" at}$

FACTORS FOR ALLOYS

Percentage Desired in Metal	PER CENT ALLOY									
	80		81		82		83		84	
	A	B	A	B	A	B	A	B	A	B
.10	.00125	.00125	.00124	.00123	.00122	.00122	.00121	.00120	.00119	.00119
.20	.00251	.00250	.00247	.00247	.00244	.00244	.00242	.00241	.00239	.00238
.30	.00379	.00375	.00372	.00370	.00367	.00366	.00362	.00361	.00358	.00357
.40	.00503	.00500	.00496	.00494	.00490	.00488	.00484	.00482	.00478	.00476
.50	.00629	.00625	.00621	.00617	.00613	.00610	.00606	.00602	.00599	.00595
.60	.00756	.00750	.00746	.00741	.00737	.00732	.00728	.00723	.00719	.00714
.70	.00883	.00875	.00872	.00864	.00861	.00854	.00850	.00843	.00840	.00833
.80	.01010	.01000	.00997	.00988	.00985	.00976	.00975	.00964	.00961	.00952
.90	.01138	.01125	.01124	.01111	.01110	.01098	.01096	.01084	.01083	.01071
1.00	.01266	.01250	.01250	.01235	.01235	.01220	.01219	.01205	.01205	.01190
1.10	.01394	.01375	.01377	.01359	.01360	.01344	.01343	.01525	.01327	.01309
1.20	.01523	.01500	.01504	.01482	.01485	.01464	.01467	.01446	.01449	.01428
1.30	.01652	.01625	.01631	.01605	.01611	.01586	.01591	.01566	.01572	.01547
1.40	.01781	.01750	.01759	.01729	.01727	.01707	.01716	.01687	.01695	.01667
1.50	.01911	.01875	.01887	.01852	.01863	.01829	.01840	.01807	.01818	.01786
1.60	.02041	.02000	.02015	.01976	.01990	.01951	.01965	.01928	.01942	.01905
1.70	.02171	.02125	.02144	.02099	.02117	.02073	.02091	.02048	.02066	.02024
1.80	.02302	.02250	.02273	.02223	.02244	.02195	.02217	.02169	.02190	.02143
1.90	.02433	.02375	.02402	.02346	.02372	.02317	.02343	.02289	.02314	.02262
2.00	.02564	.02500	.02532	.02469	.02500	.02439	.02469	.02410	.02439	.02381
2.10	.02696	.02625	.02662	.02592	.02628	.02561	.02596	.02530	.02564	.02500
2.20	.02828	.02750	.02792	.02716	.02757	.02683	.02723	.02651	.02689	.02619
2.30	.02960	.02875	.02922	.02839	.02886	.02805	.02850	.02771	.02815	.02738
2.40	.03093	.03000	.03053	.02963	.03016	.02927	.02978	.02892	.02941	.02857
2.50	.03226	.03125	.03185	.03086	.03145	.03049	.03106	.03012	.03067	.02976
2.60	.03359	.03250	.03316	.03210	.03275	.03171	.03234	.03133	.03194	.03145
2.70	.03493	.03375	.03448	.03333	.03405	.03293	.03362	.03253	.03321	.03264
2.80	.03627	.03500	.03580	.03457	.03535	.03415	.03491	.03374	.03448	.03333
2.90	.03761	.03625	.03713	.03580	.03666	.03537	.03620	.03494	.03576	.03452
3.00	.03896	.03750	.03846	.03704	.03797	.03659	.03750	.03614	.03704	.03571
3.10	.04031	.03875	.03979	.03827	.03929	.03771	.03860	.03734	.03832	.03690
3.20	.04167	.04000	.04113	.03951	.04061	.03903	.04010	.03855	.03960	.03810
3.30	.04302	.04125	.04247	.04074	.04193	.04025	.04140	.03975	.04089	.03929
3.40	.04439	.04250	.04381	.04198	.04326	.04146	.04271	.04096	.04218	.04048
3.50	.04575	.04375	.04516	.04321	.04459	.04268	.04403	.04216	.04348	.04167
3.60	.04712	.04500	.04651	.04445	.04592	.04390	.04534	.04337	.04478	.04286
3.70	.04849	.04625	.04787	.04568	.04725	.04512	.04666	.04457	.04608	.04405
3.80	.04987	.04750	.04922	.04692	.04859	.04634	.04798	.04574	.04739	.04524
3.90	.05125	.04875	.05058	.04815	.04994	.04756	.04930	.04698	.04869	.04643
4.00	.05263	.05000	.05195	.04938	.05128	.04878	.05063	.04819	.05000	.04762
4.50	.05960	.05625	.05882	.05555	.05806	.05488	.05732	.05421	.05660	.05357
5.00	.06667	.06250	.06579	.06173	.06494	.06098	.06410	.06024	.06329	.05952
5.50	.07383	.06875	.07285	.06790	.07190	.06708	.07097	.06626	.07006	.06547
6.00	.08108	.07500	.08000	.07407	.07895	.07317	.07792	.07229	.07692	.07143
6.50	.08842	.08125	.08725	.08024	.08609	.07927	.08497	.07831	.08387	.07738
7.00	.09589	.08750	.09459	.08642	.09333	.08537	.09210	.08434	.09091	.08333
7.50	.10340	.09375	.10200	.09259	.10070	.09147	.09934	.09036	.09804	.08928
8.00	.11110	.10000	.10960	.09875	.10810	.09756	.10670	.09638	.10530	.09524
8.50	.11970	.10620	.11720	.10490	.11560	.10370	.11410	.10240	.11260	.10120
9.00	.12680	.11250	.12500	.11110	.12330	.10980	.12160	.10840	.12000	.10710
9.50	.13470	.11870	.13290	.11730	.13100	.11590	.12920	.11440	.12750	.11300
10.00	.14290	.12500	.14080	.12350	.13890	.12200	.13700	.12050	.13510	.11900
10.50	.15110	.13120	.14890	.12970	.14680	.12810	.14480	.12650	.14290	.12490
11.00	.15940	.13750	.15710	.13580	.15490	.13440	.15280	.13250	.15070	.13090
11.50	.16910	.14370	.16550	.14200	.16310	.14050	.16080	.13850	.15860	.13680
12.00	.17650	.15000	.17390	.14820	.17140	.14640	.16900	.14460	.16670	.14280
12.50	.18520	.15620	.18250	.15440	.17990	.15250	.17730	.15060	.17480	.14870
13.00	.19400	.16250	.19120	.16050	.18840	.15860	.18570	.15660	.18310	.15470
13.50	.20300	.16870	.20000	.16670	.19710	.16470	.19420	.16260	.19150	.16060
14.00	.21210	.17500	.20900	.17290	.20590	.17070	.20290	.16870	.20000	.16670
14.50	.22140	.18120	.21800	.17910	.21480	.17680	.21170	.17470	.20860	.17260
15.00	.23080	.18750	.22730	.18520	.22390	.18290	.22060	.18070	.21740	.17860
15.50	.24030	.19370	.23660	.19140	.23310	.18900	.22960	.18670	.22630	.18450
16.00	.25000	.20000	.24610	.19760	.24240	.19510	.23680	.19280	.23530	.19050
16.50	.25980	.20620	.25580	.20380	.25190	.20120	.24810	.19880	.24440	.19640
17.00	.26980	.21250	.26560	.20990	.26150	.20730	.25760	.20480	.25370	.20240
17.50	.28000	.21870	.27560	.21610	.27130	.21340	.26720	.21080	.26320	.20830
18.00	.29030	.22500	.28570	.22230	.28120	.21950	.27690	.21690	.27270	.21430
18.50	.30080	.23120	.29600	.22850	.29130	.22560	.28660	.22290	.28240	.22020
19.00	.31150	.23750	.30640	.23460	.30160	.23170	.29690	.22890	.29230	.22620
19.50	.32230	.24370	.31710	.24080	.31200	.23780	.30710	.23490	.30230	.23210
20.00	.33330	.25000	.32790	.24690	.32260	.24390	.31740	.24100	.31250	.23810

Note—There are 20 full pages of factors. Available upon request to the editor.

Percentage Desired in Metal	4.00% Carbon Pig Iron Containing 3% Silicon		50% Ferro Silicon	80% Ferro Manganese Containing 6% Carbon	
	Carbon Factor	% Silicon Will Effect Metal	Silicon Factor	Manganese Factor	% Carbon Will Effect Metal
.01	.00250	.007	.0002	.00012	...
.02	.00500	.015	.0004	.00025	...
.03	.00750	.022	.0006	.00037	...
.04	.01000	.030	.0008	.00050	...
.05	.01250	.037	.0010	.00062	...
.06	.01500	.045	.0012	.00075	...
.07	.01750	.052	.0014	.00087	...
.08	.02000	.060	.0016	.00100	...
.09	.02250	.067	.0018	.00122	...
.10	.02500	.075	.0020	.00125	.007
.15	.03750	.112	.0030	.00187	.012
.20	.05000	.150	.0040	.00250	.015
.25	.06250	.187	.0050	.00312	.017
.30	.07500	.225	.0060	.00375	.022
.35	.08750	.262	.0070	.00437	.026
.40	.10000	.300	.0080	.00500	.030
.45	.....	...	.0090	.00562	.034
.50	.....	...	.0100	.00625	.037
.55	.....	...	.0110	.00687	.041
.60	.....	...	.0120	.00750	.045
.65	.....	...	.0130	.00812	.049
.70	.....	...	.0140	.00875	.052
.75	.....	...	.0150	.00937	.056
.80	.....	...	.0160	.01000	.060
.85	.....	...	.0170	.01062	.064
.90	.....	...	.0180	.01125	.067
.95	.....	...	.0190	.01187	.071
1.00	.....	...	.0200	.01250	.075

4.00 per cent desired at 70 per cent alloy is $.057 = 80$ lbs. chrome.

Total ferro chrome = 223 lbs.

Third Operation.

As the bath already contains 100 per cent Va. and .50 per cent additional is desired, then 10,000 lbs. $\times$ Factor "B" at .50 per cent desired and 39 per cent alloy is $.0123 = 128$ lbs. Va.

Now the 1400 lbs. of alloys must also contain 1.50 per cent Va. Therefore, 1400 lbs. $\times$ Factor "B" at 1.50 per cent desired at 39 per cent alloy is $.038 = 53$ lbs. Va.

Total ferro vanadium = 181 lbs.

Fourth Operation.

There are such small percentages of manganese and silicon in the metal that only one calculation is necessary for each of these alloys:

.15% Ferro Mn = $11400 \times .00187 = 21$ lbs.

.15% Ferro Si = $11400 \times .003 = 34$ lbs.

Comparing the above results with those calculated for this high speed steel heat in section "A" you will find the resulting pounds of alloys almost identical.

Where the total alloy additions are estimated fairly accurately, you will find the calculations with "B" factors much more rapid than when "A" factors are used. Wherever the usual methods are used, the application of either "A" or "B" will greatly simplify the operation.

To eliminate the carrying of excess material, it is suggested that the calculator copy for ready reference on suitable sheets only ferro alloys available and to the classes of metals being produced. For many years the author has used the following table of "B" factors in calculating alloy additions for simple steels:



MR. DONALD N. WATKINS

RETURNS TO STEEL-MAKING

Donald N. Watkins has been appointed Superintendent of Blooming Mills at the South Side plant of the Jones & Laughlin Steel Corporation of Pittsburgh.

As Editor of this magazine, Mr. Watkins built up a host of friends and acquaintances throughout the Pittsburgh district and the steel industry in general.

In his new work, for which his earlier experiences, and genial nature thoroughly fit him to succeed, he carries a world of best wishes.

Congratulations, Watty!

THE SAFETY CRUSADE

What is an Eye Worth?

How many are there who depend upon your eyes for their comfort and happiness? Your wife and children and maybe others look to you to provide them with the necessities of life. Upon your ability to produce rests their welfare. And of the five senses, none is more vital as a breadwinner than that of seeing. Minus your eyes you become—for the time being at least—a non-producer, a liability, instead of a virile capable worker.

Do you appreciate your eyes? Nearly 200,000 persons in industry suffer eye injuries yearly. A substantial majority of these are unnecessary. Unnecessary because for a moment goggles were laid aside; because a shield was neglected; because someone forgot or was careless, or scorned to wear the protection provided.

Why do men object to wearing goggles? Some say, "They are too heavy. They hurt my nose. They hurt my ears. They look funny. The lenses get cloudy. They're in the way."

Poor excuses, all of them. Do they try to get goggles that are satisfactory, or do they just throw them aside, saying, "I'll take a chance"?

What happens when goggles or face masks are not worn and an eye is lost? Pain and suffering, disfigurement of features, loss of earning power, life long regret. We who have eyes look with pity on those who have one or none to see with. But unless we profit by their example we are in danger.

Do things sometimes look blurred to you? How often do you have headache or eye ache; do your eyes feel puffy and watery or inflamed? These are often Nature's warning that you have defective vision and that in addition to goggles you need the attention of an oculist. Some day you are going to be fooled by those nearsighted or weak eyes of yours and get hurt. Next to the hazards to the eye itself through lack of protection, comes the danger from poor eyesight. It is said that over 25,000,000 persons who are working in the United States are handicapped by defective vision or eye strain—almost one-quarter of the nation's population. Better check up!

No word should be necessary as to when to guard the eyes. Flying sparks or splashing molten metal, flying bits from flying chips, castings and battered tools, emery wheels, injurious light rays and intense heat from high temperature welding, steam, hot water, or bursting glass, acid burns and chemicals, are causes of eye accident that are preventable if the proper caution is observed.

You may be willing to take some chances, but the chance of blindness you *cannot* take and still expect to derive much from life.

Skilled doctors in a New Jersey city recently, in a desperate effort to restore eyesight to a youth blinded by a Fourth of July explosion, grafted parts of a pig's eye onto one of the injured eyes. The attention of the world is on that experiment. If it is successful, science will have made another advance—but don't depend too much on that. A pig's eye may not look well on you.

National Safety Council Calendar.

The value of your good vision cannot be expressed in any terms. Look at it from the viewpoint of your family, yourself and your life in general and then ask, "Can I afford not to protect my eyes?"

COMMUNICABLE DISEASES AND TRAVEL

Uniform provisions governing the travel of persons suffering from contagious diseases are now in force over a large part of the United States, says the U. S. Public Health Service, in a bulletin just issued. Twenty states (Alabama, Florida, Georgia, Illinois, Kansas, Kentucky, Louisiana, Maine, Maryland, Michigan, Minnesota, Mississippi, New Hampshire, North Dakota, South Carolina, Tennessee, Virginia, West Virginia, Washington and Wisconsin) have already adopted the Standard Railway Sanitary Code approved by the conference of the state and provincial health authorities of North America and later by the U. S. Public Health Service in conference with the health officers of the United States. The essential part of the code has also been incorporated in the United States interstate quarantine regulations, which apply to travel from one state to another.

SAFETY ENGINEERS MEET AT CHICAGO

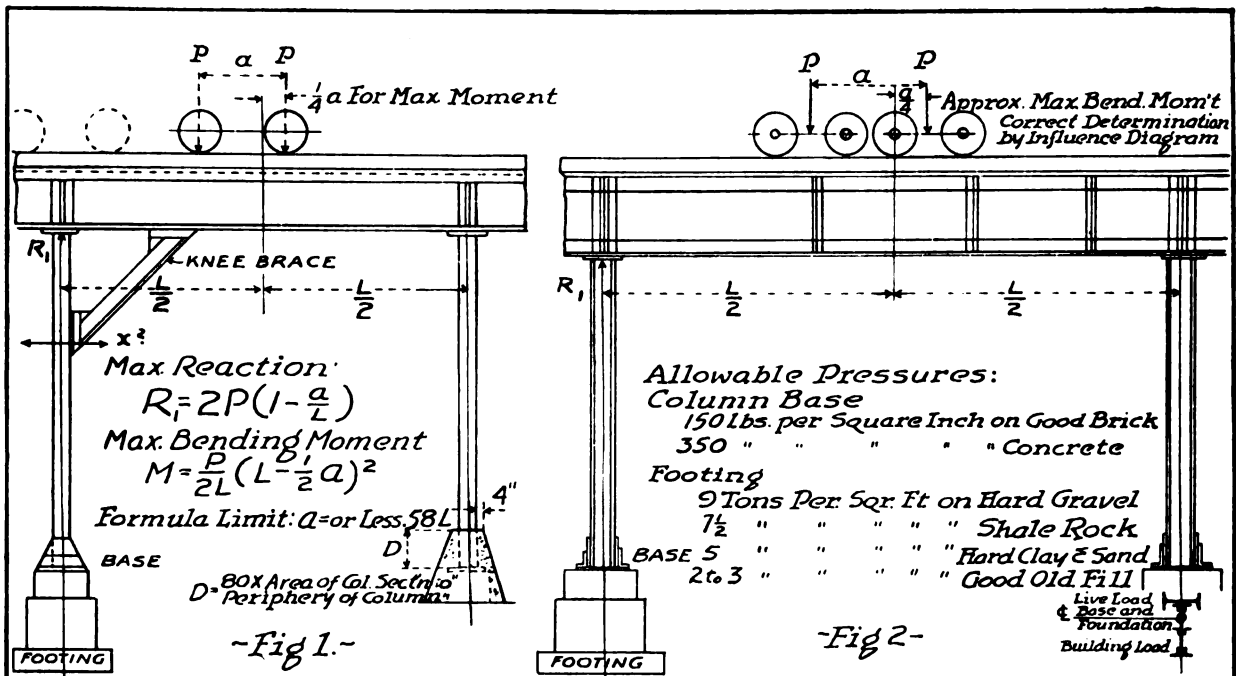
A midyear safety conference has been called by the Engineering Section of the National Safety Council at Chicago, Ill., April 17, in the auditorium of the Western Society of Engineers, 53 W. Jackson Boulevard. Handling Material, Dust and Fume Hazards, and Traffic Safety are the three main topics on the program.

The morning session will deal with causes of accidents in handling materials, and use of conveyors and trucks in eliminating material handling accidents, followed by a general discussion of specific safety problems in material handling. George F. Fonda, of Fonda-Tolsted, Inc., Washington, D. C., chairman of the Engineering Section of the Council, will preside at the morning meeting.

Preventing dust fires and explosions, health protection against dust, and a discussion of practical methods of dust and fume removal will follow in the afternoon. Homer E. Niesz, Commonwealth Edison Company, Chicago, and treasurer of the National Safety Council, will preside at the banquet in the evening at which traffic problems will be discussed.

QUALIFICATIONS OF THE SAFETY MAN

The safety man in modern industry must be a many-sided individual with patience, tact, and ability of high order, according to Marcus A. Dow, president of the National Safety Council, who says that to be successful in his work the head of an industrial safety department must have these qualifications: He must believe in the dignity of his calling. He must be more or less of an engineer, a lawyer, diplomat, physician, accountant. He must avoid "passing the buck" and assume full responsibility for accident conditions. He must understand human nature. He must have a sense of balance, of perspective. He must see his job as an aid to production, not a hindrance. He must see his job as an aid to better industrial relations. He must see his job as a bit of applied Christianity.



LOADING EFFECT OF TWO GIRDERS OF SAME SPAN & SECTION

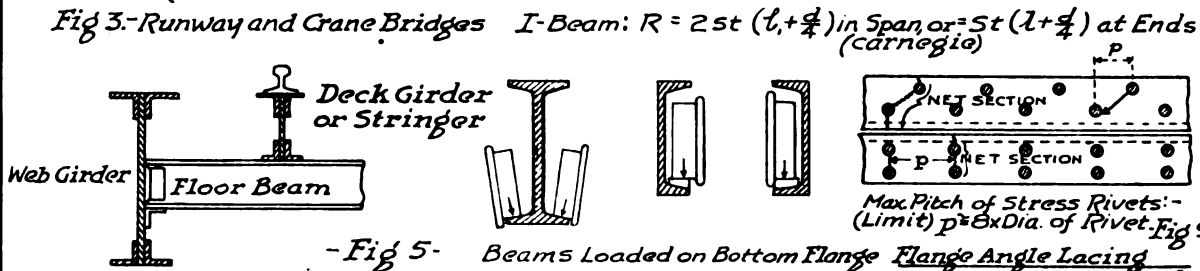
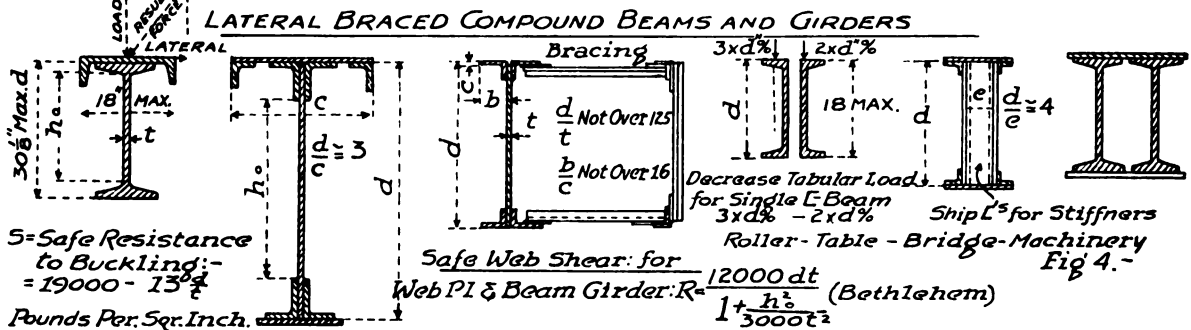
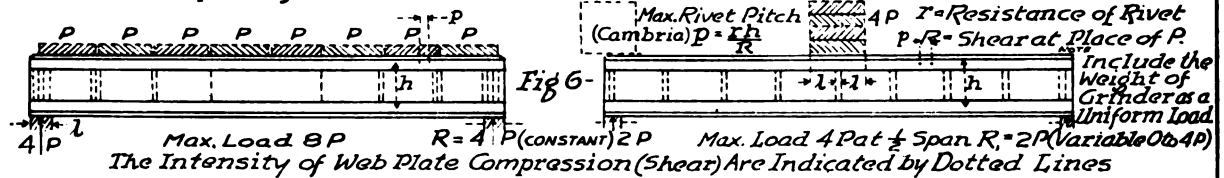
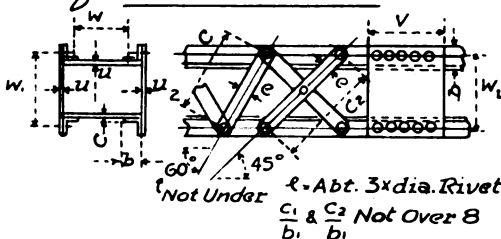
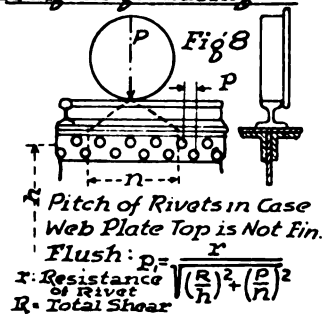


Fig 7-Columns & Struts



Cover Plate $\frac{W_1}{U_1}$ Not Over 40
 Web Plate $\frac{W_1}{U_1}$ Not Over 40
 Lattice Pl. $\frac{W_2}{U_2}$ Not Over 50
 Lattice Pl. $\frac{V}{W_2}$ Not Under 1
 Flange L's $\frac{V}{C}$ Not Over 12
 Lattice Bar $\frac{C_1}{U_2} \approx 40; \frac{C_2}{U_2} \approx 50$
 Not Over



FORMULAS USED IN STRUCTURAL ASSEMBLY

Steel Structures

A Concise Analysis of the Factors Entering into the Assembly of Steel Shapes.

By ULRICH A. PETERS

THE numerous products of the steel mills have improved their own facilities as well. Now, that steel has come into such universal use as structural material for bridges, buildings, material handling and machine frames, it would be surprising to see the steel mills in old buildings with antiquated furnaces and machinery, and men handling the material in process with hooks and push trucks.

Steel made possible the development of powerful equipment for turning out large quantities of various products. To conceive of the bulk handled from mine to mill and from mill to shipping—we have only to consider: A trimming loss of 30 per cent, from each ton of trimmed plates ordered so that the plate mill will roll 2600 pounds of untrimmed plates. This requires 2684 pounds of slabs from the blooming mill to allow for a scale and cinder loss of about 4 per cent. Prior to this the blooming mill with soaking pit furnaces will demand 33 per cent for discard, crop ends, and scale—which means 3570 pounds of ingot from the mould stripper yard for the 2000 pounds of trimmed plate. In the open hearth furnaces they tell us of Monel and trade heats, using scrap, less in the former and more in the later. To melt 3570 pounds of open hearth steel we must charge for the Monel heat: 360 lbs. limestone—a total of 4880 pounds. For delivering 3,000 lbs. of pig iron to mixer and open hearth departments from the blast furnaces the skip hoist must throw in 3520 lbs. coke, 7100 lbs. ore and 2220 lbs. limestone at the furnace top. The large bulk of dump and tramp loads, consisting of coal, slag, ashes, cinder, ladles, moulds, etc., are omitted.

The traveling machines which do the handling of the material, are naturally subjected to considerable wear and tear under the hard and continuous working hours in the steel works. The total number of these machines per rolling mill employed is around 20 in the average and, on account of their importance to the operations, some spare or emergency machines are kept as a practical necessity.

The structures in steel works represent a chain of tracks and runways for the moving machines forming the connecting links between railway tracks, storage bins, furnaces and mill machinery. The arrangement of these high and by-ways when not fixed by the disposition of furnaces, railroad tracks and other conditions may have been selected from the viewpoint of economy in investment—a problem of the least cost in the sum of:

- Roof trusses and floor beams, if any, plus
- Runway girders of any assumed span, plus
- Columns with foundation.

All based on the linear foot of runway.

Taking several estimates on such layouts of different girder spans at the prevailing prices for labor and material, a certain bay spacing will prove the

most desirable for the treasury department.

Suitable column sections are those requiring the least punching for rivets, as according to tests a solid rolled column is considerably stronger than a riveted built up section of the same area and dimensions.

Notations about the spread of column bases and foundation footings are for evenly distributed pressures—sometimes, excessive corner pressures crush and wiggle the column foundation loose, due to mislocation of the load—see center line Fig. 2.

Where heavy bumps are frequent kneebraces prove to be of very little value, as they place undue stresses directly on the column.

A recent practice imbeds the column shaft into a solid foundation of concrete Fig. 1. This method also permits the reconditioning of columns for heavier loads.

In the selection of girders, where beams of the rolled sizes are not adequate, girders of the built up types are employed; Figs. 3 and 4.

A beam or girder carrying a live and dead load is of the character shown in the Fig. 5, each requiring considerations in accordance to the load applied, whether on the top flange, web plate, or bottom flange. Wheel loads in steel mills are much at variance, from less than 1000 pounds to over 200 times that amount.

A simple fundamental for the design of girders is:

Net area required for one flange in square inch metal =

Maximum Bending Moment

Stress per sq. in. $\times$ Effective Depth

The logical arrangement for the pitch of rivet spacings and web stiffeners are determined by first bearing in mind two extreme cases of loading Fig. 6, aside from those shown in the sections of Fig. 5. Any girder will represent a combination of similar conditions requiring stiffener angles or no stiffeners for the web plate and a rivet lacing as may be calculated.

Similarly, any lateral loads tending to twist the girder are figured and taken care of. Suitable provisions for withstanding momentum, drag and wind actions are shown in the girder types of Fig. 3.

Under any case, the weight of the girder is taken as an additional uniformly distributed load.

For structures exposed to the outside yards we would allow as protective paint a veneer of rust—equivalent to about 1/16 in. of metal—while for inside paint—it may be either grease or dust.

For the benefit of those interested in the structural lines, certain proportions in regard to struts and columns, to which good practice tends to adhere, are given in the sketch Fig. 7.

The proportioning of the built-up type girders is a simple matter to those who know how to dissect and

determine from the figured stresses, those which may actually occur over a certain portion of the beam, so as to distribute and dissipate properly the load through the metal forming a combination of sections by splicing and riveting. Where the ends of members are spliced the splice plates or angles whatever they may be are subpunched about $\frac{1}{8}$ in. smaller in diameter and reamed to size in place, thus insuring a good bearing of the finished or milled ends.

In case of a well spliced rail on top of a girder, the concentrated wheel load will be spread out for some distance over the girder length as noted in Fig. 8.

This spread n is approximately:

$$n = 50,000 \times \frac{\text{Section Modulus of Rail and Flange Angles}}{\text{Wheel Load in Pounds}}$$

Without a rail, the top row rivets may be ripped

out under a heavy wheel load unless the upper edge of the web plate is finished and made to bear against the cover plate and rail. Wheel loads of the heavy kind could be also divided up by the employment of equalizer trucks, Fig. 2.

Stiffener angles of suitable section, crimped or on fillers and fitted to the top and bottom flanges are added to the web plate and spaced so as to make up for the deficiency in the web resistance to crushing, this especially at the ends.

The practice of staggering the rivets is advisable where close rivet spacing demands good clearances for the riveting machine, and for the material economy as well. Certain rules for same are given in the Steel Companies' Handbooks. To stick to these rules is a matter of fabricating facilities. At any rate, the shops appreciate such layouts where punchings run parallel, vertically and horizontally, and do not represent a mixed smire of riveting.

Flange angles lose about 13 per cent with one hole out, 20 per cent with two holes out and 23 to 30 per cent with three to four holes out. Therefore, nothing is gained in the bending resistance of a built-up section, by useless rivets which take out material that is again replaced by additional cover plates—more may be gained by a more careful arrangement of the flange and web rivets to maintain the greatest possible net section, Fig. 9.

Joliet Furnace Blows In

Completely Rebuilt — With Ample Provision For Future Enlargement.

The Illinois Steel Company have recently completed the rebuilding and remodeling of Number 3 blast furnace at the Joliet plant.

The furnace was blown out August 5, 1922, and is now in blast again on her increased tonnage schedule.

The general dimensions of No. 3 Furnace for the proceeding campaign were as follows:

Hearth 17 ft., diameter at mantel 21 ft. 6 in., height of stack 89 ft. 6 $\frac{3}{4}$ in., number of tuyeres 10, number of columns 8, average thickness of brickwork 3 ft. 7 in.

No. 3 furnace was blown out for general relining August 5, 1922. It had been decided to modernize the

*"The Mixer."

furnace in every way possible in order to anticipate future tonnage demands as well as contemplated improvements in raw material handling. The furnace was cleaned out and the salamander or iron accumulation removed to permit remodeling. The first step was to increase the diameter of the bottom to allow greater hearth room. Forethought here has discounted the future and provision has been made to permit a hearth diameter up to 20 ft. 9 in., simply by decreasing the thickness of the brickwork at this point without the added cost of general enlargement. The size of the hearth for the present campaign is 19 ft. thus leaving a margin of 1 ft. 9 in. for increased diameter which will no doubt be utilized for future campaigns. The columns have been moved out, placed at an angle and the number increased from 8 to 10. This increase not only adds supporting strength to the stack and top of the furnace, but also provides uniform spacing distance between tuyeres of which there are 10. This is an ideal condition from more than one angle: viz. A tuyere between each two columns and in line with a tuyere directly opposite, completely around the circle. Tuyeres spaced between columns in this manner give



Recently completed blast furnace.

ample working area, a very desirable condition from a safety and operating standpoint.

To fortify the increased size of the bottom as well as to back up the column foundation, a deep girdle of reinforced concrete has been installed on the outside of the hearth jacket, making an effective bulwark against breakouts, expansion stresses, etc.

A new crucible jacket has been provided, one which will take care of the maximum hearth diameter of any future campaign. The cooling area of the section has been increased by large water pipes. The jacket is tightly bricked in with six courses of 18 in. x 9 in. x 4 $\frac{1}{2}$ in. bottom blocks and sided up with approximately 40 inches of refractory brick.

A decided change has been made in the Bosh construction of No. 3 furnace. The height has been cut down and bricked to a steeper angle, and a new feature has been added with the installation of a tuyere jacket. This jacket takes the place of the spaced bosh bands plus the added strength of a one-piece construction of heavy steel plate. It is ideal from a safety standpoint primarily, and should merit the applause of any person inclined toward safety first. From an operating standpoint it is an aid inasmuch as the jacket is laid out for correct spacing of blast inlets and permits symmetrical distribution of the bronze cooling plates. This should tend to a smooth working furnace as the fusion zone is but a short distance above the tuyere line and well distributed cooling units tend to keep the bosh wall smooth and regular. The uniform spacing

made possible by the openings in the jacket insure good wind distribution at all times. Above the tuyere jacket up to the mantel the bosh is bricked in the usual manner and encircled by heavy bosh bands. Here the brick work is thickly studded with symmetrically laid bosh cooling plates, the number having been increased for this campaign.

A new heavy duty mantel of approved design to help carry the upper brick work is also part of the new equipment.

An enlarged furnace, of course, requires larger outside essentials so that a new circle pipe and over-flow trough to handle the cooling water were necessary as well as a new bustle pipe to handle and distribute the wind or blast to the tuyeres. The bustle pipe is lined with refractory brick and insulated with fire-felt, an asbestos preparation designed to cut down radiation losses. Much of the shell work has been renewed, buckled plates and weak areas replaced with new steel plates.

The top is stationary with large and small bell, gas seal, etc., and the type of receiving hopper the same as on No. 4 furnace and similar to the receiving hoppers in use on all furnaces at the South Chicago plant.

A general summary of the dimensions of No. 3 furnace and the amount of brick used in relining will no doubt be of interest.

Diameter of hearth, 19 ft.
Diameter at mantel, 22 ft. 6 in.
Diameter at stack line, 17 ft.
Diameter of big bell, 13 ft.
Diameter of small bell, 5 ft. 3 in.

Eleven courses of wearing plates at stock line or a flat wearing surface of 8 ft. 3 in.

Number of Bosh cooling plates, 186.

The brick used for relining were of the following sizes:

9 in. x 6 in. x 3 in. straights and keys.
13½ in. x 6 in. x 3 in. straights and keys.
18 in. x 9 in. x 4½ in. bottom blocks.

Number of bricks used:

Bottom of furnace to top of hearth jacket	110,000
Hearth jacket to mantel	35,000
Mantel to top of furnace	270,000

Total	415,000
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or a 9 in. equivalent of 28 cars of brick used for the relining of No. 3 Blast Furnace.

She has our best wishes. Let's go!

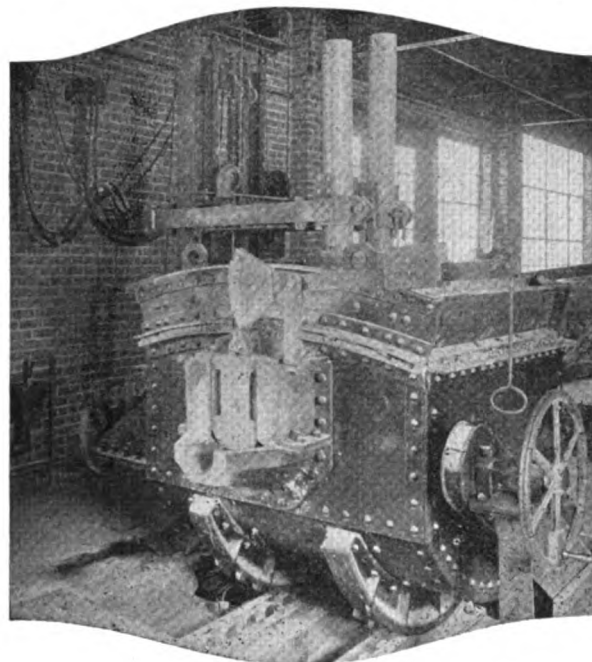
Electrically Melted Ferro-Manganese Improves Converter and Open Hearth Practice

By FRANK HODSON*

It is now generally agreed that it is very desirable to make molten ferro-manganese additions to open hearth and converter steels rather than to cold unmelted metal. Bessemer first recommended this, but the advent of the electric furnace has made it possible to do this in a sim-

*President Electric Furnace Construction Company, Philadelphia, Pa.

ple and efficient manner. Ferro-manganese is not an easy alloy to melt and handle when required intermittently and it is probably the difficulties with the melting equipment that has prevented wider use of molten manganese. A properly designed electric arc furnace with bottom contact to insure circulation in the bath and a large bath area to permit of proper slag manipulation will solve many of the melting difficulties previously experienced and insure at a low operating cost supplies of real hot liquid ferro-manganese. The effect of such hot ferro-manganese on steel either just before pouring it or in the ladle is very much more pronounced than when the cold alloy is added. In England, where several such fur-



Small electric furnace.

naces have been operated for some time, and in Germany, where the complicated induction furnace, with its low power factor is used for the same purpose, it has been found that the actual amount of ferro-manganese used can be reduced 30 or 40 per cent in favor of the molten process. Coupled with this, the resultant steels have been more free from gases, occluded oxides and slag, and the waste and rejections have been much less.

The resultant steels roll and forge more easily than when ferro-manganese is added cold, as it is safe to say that if 0.5 Mn. were the minimum amount to enable a given steel to roll, probably if molten ferro were substituted 0.35 to 4 would give a steel that would roll easily. In addition to better quality of steel, to less amount of ferro, and to absence of melting loss, additional savings can be made by the use of manganese ore, inferior fines and low grade ferro-manganese. All these can be used in the electric furnace. In experiments made on a "Greaves-Etchells" furnace—which furnace has the particular advantage of operation either entirely with top electrodes, or with top electrodes and whole of furnace hearth—as much as 25 per cent of the charge was added in the form of manganese ore. The metallic melting loss rarely exceeds 2 per cent.

With proper metallurgical manipulation of ferro-manganese, it becomes highly desirable to use an electric furnace with a large open bath rather than a restricted channel.

The Super-Synchronous Motor

A Recent Development Which Holds Forth Much Promise in Steel Mill Applications—Greatly Improved Starting Characteristics.

By W. L. MERRILL*

SEVERAL factors have contributed to the prominence to which the economical and electrical advantages of the synchronous motor for machine drive has attained in the minds of engineers, and to the increasing desire to realize the effect of these advantages on power bills and plant operation generally. One of the more influential of these factors is the growing tendency of power companies to insert penalty-bonus clauses in their power contracts. This makes the comparative power factors of synchronous and induction motors, especially on applications requiring slow speed drive, a subject of considerable interest to large users of power. Therefore, although handicapped for many applications, the syn-

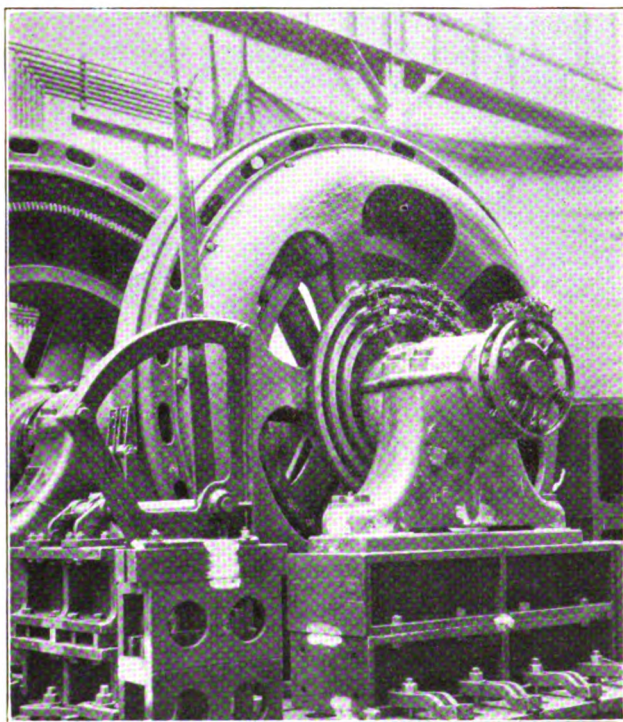
teristics to remove these limitations, it should be of considerable value to the user of electric power.

Such a motor has been recently designed and built by the General Electric Company, which is termed, for reasons which will appear, the "super-synchronous motor." This motor has shown on test that it will develop a torque of from 150 to 200 per cent of normal throughout the starting period, as the torque available at the shaft is equal to anything below the pull-out torque of the motor, and is proportional to the current. While the construction of the new motor embodies certain features that have been used successfully on other apparatus, the electrical and mechanical principles of its operation are sufficiently novel to be interesting.

In appearance, the new synchronous motor somewhat resembles those of ordinary types, with the exception that the frame is equipped with a band brake similar to those on mine hoists. As to operation, in starting, the brake is released, and current admitted to the armature, which is free to revolve, bringing it up to synchronous speed, regardless of the load. The field is held stationary during this period by the friction of the load, to which it is directly connected through a coupling. When the armature is at synchronous speed, current is admitted to the field, as in the ordinary synchronous motor, and the brake is gradually applied manually to the armature frame. As the latter slows down, the field and its load are brought gradually up to speed until, with the armature lock locked stationary by the setting of the band brake, the motor is functioning as a conventional synchronous motor.

As to the field of application of the super-synchronous motor, it is especially applicable to driving heavy line shafts, fans, centrifugal pumps, or heavy machines that run at low speeds, and require excessive starting torque. An example of the latter is the ball and tube mill used in cement manufacture. In the case of centrifugal pumps, where these are started under full head, in the past, when ordinary synchronous motors were used, two alternatives were possible, neither of which really solved the problem satisfactorily. One was to "over-motor" the pump, and the other was to use an elaborate system of clutches, and extra bearings, which expedients were resorted to because of the low pull-in torque of the synchronous motor. With the new motor both of these evils are eliminated.

As to its practicability in driving ball and tube mills, the test mentioned above offers conclusive proof as to the abilities of the new motor. Referring to the figures given in the description of the test, it will be seen that the 450-hp. motor used accelerated a load requiring 45,000 hp.-seconds. A 7-ft. by 22-ft. ball and tube mill, with a total weight of 165,000 pounds, requires approximately 630 hp.-seconds to bring it up to its normal speed of 20 rpm. Therefore the motor has proved, in test, that it can exert 72 times the hp.-seconds required to start such a mill and, what is more, do it not once but repeatedly.



New super-synchronous motor.

chronous motor is replacing the induction motor for direct connected drive in many instances. The principal one of these handicaps is the necessity of using clutches between the motor and the driven machine, and is imposed by the low starting and pull-in torque that is characteristic of synchronous motors. The necessity of using clutches has constituted a limitation for several reasons, chief among them being the large amount of space taken up by the clutches and their bearings, the increased maintenance charges and the necessity for the accurate aligning of the motor and the driven machine. If a synchronous motor could be designed with such starting charac-

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CURRENT TECHNICAL DIGEST

RUHR INVASION CHANGES INTERNATIONAL CALCULATIONS

Unexpected changes have accompanied the French and Belgian invasion of the Ruhr region.

Under the cloak of political expediency, an age old desire to possess or control this concentrated hive of industry has been gratified. From the moment when Foch advocated the "Rhine boundary" for France's protection, every move has shown one definite tendency. Germany has furnished her own boomerang, when she failed in her attempt at reparation evasion.

A glance at the map indicates the magnitude of the operation.

Deflation and Purchasing Power.

The annual meetings of the "Big Four" in the banking world have given us the opportunity of hearing the opinions of those who are best placed to diagnose the present condition of industry. Mr. McKenna's speech at the meeting of the London Joint City and Midland Bank was the most outstanding. His theory that our policy of deflation had proceeded and was proceeding too far, to the detriment of our purchasing power, has met with a good deal of adverse criticism; but there will be many who agree that our haste to unburden ourselves of our indebtedness, and our idea, or the idea of our governors, that the restoration of parity of exchange with the United States would bring us peace and felicity, is likely to cripple us so much in the present that there will be no future worth living for. The restoration of the pre-war rate of exchange between this country and America makes conditions more favorable to the importation of American goods, and that, in view of our existing indebtedness to America, is precisely what we want to avoid.

Prices.

Had there been a fall in prices proportional to the deflation, purchasing power would not have been reduced, but there has been no such corresponding fall in prices, and buyers are still holding back for better terms, notwithstanding the oft-repeated ascertainment that bed-rock has been reached. The opinion in banking circles appears to be that prices will be stabilized about 30 to 40 per cent above pre-war prices.

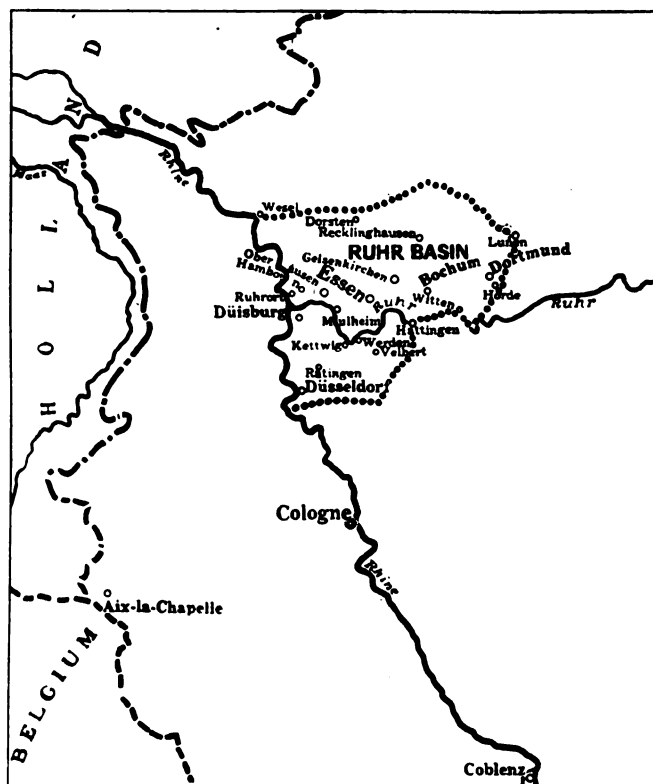
The price of labor, it is true, is nearer the pre-war level than any of the commodities it produces; but in this there is grave danger. Too many of the population are living close to the border line of destitution, and unless we see soon a substantial reduction in the cost of life's necessities we may have a recrudescence of the industrial disturbances that played such havoc with industry in 1921 and the early part of 1922. There are complaints, not unjustified, that the reduction in wages, accepted after a bitter and costly struggle, has not been followed by the promised reduction in the cost of living. The seeds of distrust are being

Engineering Review, London.

sown and will bear unpleasant fruit unless some effort is made to reduce the cost of these necessities of life, food and rent—and rates.

The Ruhr Occupation.

The French occupation of the Ruhr Valley has been of benefit to industry in this country, particularly to the iron and steel trades and to the coal trade. Orders which otherwise would have gone to the Continent have been diverted across the Channel, and the



—Iron Trade Review.

MAP OF THE RUHR BASIN

outlook in the coalfields and in the iron and steel districts is brighter than it has been since the days of the post-Armistice boom. Advantage has been taken of the demand for export coal to raise the price to the home consumer. There does not appear to be any justification for this, beyond the fact that the demand makes it possible and that the coal owners having suffered losses during the recent industrial disputes are naturally tempted to make hay while the sun shines—or, as the simile is not very apt—raise the price to the domestic consumer while the winter lasts and so recoup these losses. From the business point of view the policy is no doubt sound, but the coal owners need not complain if they receive scant sympathy when next they come to the public with their tale of woes.

COMBUSTION CONTROL FOR STEAM BOILERS

By Charles H. Smoot

Mr. Smoot calls attention to the present emphasis being laid upon investigations in and applications of combustion controls; and states the premises very clearly.

"For a short run sufficient expert attention can be maintained on the boiler, but for everyday commercial operation, few plants can afford the incidental expense, or even maintain skilled operators in efficient control of combustion."

"It does not require an extended study to ascertain that the most important elements for regulation are: 'A' the supply of air, 'B' the supply of fuel, and 'C' the ratio of fuel to air supply." It is pointed out that for a uniformly complete combustion, a fixed ratio between the elements must be maintained, and that the supply of fuel and air must be simultaneously changed with the steam requirement change. This cannot be done in one operation. Such synchronous changes require two separate methods of control, one from steam pressure, and one from air requirement.

Tracing the comparisons back to the largest combustion unit known, that is the blast furnace, Mr. Smoot calls attention to simplicity of air control used in blast furnace practice, and brings out the value of control of volume rather than pressure.

"If time be allowed during a change in fire-load, the temperature of the fuel changes with the rate of combustion so as to maintain efficient combustion. The heat storage of the boilers themselves should be used for this purpose. By allowing moderate changes in steam pressure, the heat stored in the boiler acts as a fly-wheel to equalize the load variations on the fire and reduced the necessity for rapid changes in the rate of combustion, or "under-blowing" or over-blowing."

Thicknesses of fuel beds in relation to character and size of fuel "lumps" is treated at length.

"Combustion in a boiler is a chemical process to which the ingredients of air and coal are supplied to produce heat and gas. All the coal and air fed to the furnace come out in the form of flue gas and ash. If the ingredients are supplied in proper portion, it inevitably results in the gases leaving the furnace in the same proportion. To regulate the air pressure alone is totally inadequate. There is no direct relation between air-pressure and air quantity passing through the fire, since the quantity of air is dependent upon two factors, one of which is the resistance of the fuel bed. In an underfed stoker constant pressure air regulation produces a condition of instability, but regulation of air volume gives stability. To regulate the supply of fuel and air and maintain a perfectly constant steam pressure produces inefficient fuel consumption. To maintain the fire in good condition with a rapidly changing load it is necessary that there be a change in steam pressure to absorb the momentary demand.

The obvious conclusions are reached that regulation of mixture for gaseous liquid and powdered fuel is essential, but not difficult, while for mechanical stoker, even more essential but more difficult.

Power

Combustion regulation by mechanical means has reached its proper plane, at least in the minds of progressive engineers.

While perfection has not been attained, and probably never will be, results are now being recorded which approach the ideal. It is possible to observe in daily operation boiler units, working under automatic controls, which day in and day out show charts of maximum CO₂ with slight variation together with steam charts showing virtually constant steam pressure and temperature. No engineer today need accept the premise of variables in pressure, to secure uniform efficiency.

Combustion regulation has extended to blast furnace stoves, to coke oven heating gases, to gas producers, and a variety of applications previously unconsidered, with outstanding efficiencies.

PASTEUR

Centenary of a Master Scientist

Of Louis Pasteur it is said that no one branch of science can claim a monopoly of the man's genius. Biology, medicine—almost the whole realm of scientific knowledge is in debt to him who led the way into the "realm of the infinitely small" and who, by infinite labor in research, by close observation, skillful deduction, guided by a marvelously illuminative imagination, and through masterly adaptation of his discoveries became one of the greatest benefactors of the human race.

And today the world pays him tribute. France, who never forgets her great sons, has planned a Pasteur Centenary which is to be held at Strasbourg, beginning June 1 next and continuing for four months, as announced elsewhere in this number of *Le Voyageur en France*. This is designed to be a fitting commemoration of the achievements of the great leader of modern scientific research and discovery. Participation in the celebration will by no means be limited to France. In almost every civilized country, medical men and scientists will take some means of emphasizing their debt to Pasteur. In this country, for instance, the Academy of Medicine will hold an exhibit in which will be shown the advances in medicine and surgery which are due to his discoveries and inspiration. The American Museum of Natural History will have an exhibit in which will be emphasized what science in general owe to him, and suitable commemorative exercises will be held in public schools throughout the United States. During the latter part of January a meeting was held in the Town Hall, West Forty-third Street, New York City, by the Pasteur Centennial Committee, at which the Ambassador of France presided, and addresses were made by a number of prominent educators and others.

Pasteur enriched science by establishing that disease and deterioration in most instances are due to bacteria, and he taught the world how to combat many of the ills to which mankind is heir by summoning others of their kind to fight against and exterminate these foes. Most of his great discoveries were the results of investigations undertaken in response to economic or human needs. For instance, his researches into the process of fermentation began in consequence of a Lille manufacturer consulting him in 1856 for advice as to the making of beetroot alcohol. As a result of his experiments, Pasteur struck at the widely accepted view of the time that fermentations were due to unknown molecular forces, and showed that each type of fermentation is dependent upon its own specific kind of micro-organism. His imagination leaped beyond the horizon of fermentation and his research led him much farther afield. He revealed that micro-organisms play their part in putrefaction and decomposition, and reasoned that the equilibrium of nature is

maintained by the intricate play of living things through whose activities all substances composing the bodies of animals and plants are reduced ultimately to certain elementary components, restored to the earth, taken up again by plants, and brought once more into the realm of life. This revelation put the science of biology in his debt. His discoveries in preventive medicine date from a day in 1865 when he was asked to investigate a disease among silkworms which threatened ruin to the great silk industry of Southern France, and to find a remedy. His study of the silkworm problem convinced him that many human diseases, and that of the silkworm as well, are due to micro-organisms, and this led him to the conquest of anthrax, of cholera and hydrophobia.

Pasteur was born at Dole (Jura), December 27, 1822. Graduated from the Ecole Normale, in Paris, in 1847, the next year he became Professor of Physics at Dijon, and in 1849 accepted the Chair of Chemistry at the University of Strasbourg, remaining there until 1854, when he was called to Lille as Dean and Professor of Chemistry in the Faculty of Sciences. In 1857 he was made Scientific Director of the Ecole Normale Supérieure, and in 1863 was chosen Professor of Geology, Physics and Chemistry at the Ecole des Beaux Arts. From 1867 to 1889 he was Professor of Chemistry at the Sorbonne. Some years later he founded the Institute Pasteur in Paris, and there he surrounded himself with other famous scientists who assisted him in carrying on the great research work he had begun and developed. He died near Saint-Cloud, September 28, 1895.

Le Voyageur en France.

CHARLES M. SCHWAB

A Strong Advocate of Air Navigation, Says Flying Is Now Safe.

In an article written for the Aeronautical Digest, and made public by the National Aeronautical Association, Charles M. Schwab says:

"Properly regulated and properly conducted, air navigation can be made safe. It is only the unregulated use of aircraft with reckless 'stunt' flying which has cost us lives.

"This, of course, is aside from the military and naval use of aircraft, which is largely experimental and consequently hazardous. The commercial use of aircraft is the legitimate use, although there is no greater factor in the common defense of our country than a well developed air power. Aircraft employment during the great war and in the aerial bombing experiments against naval vessels since that time have given conclusive proof of the military and naval value of aircraft, both lighter and heavier than air.

"That flying is safe is proved, however, in the performance of commercial aircraft in this country in the past two years. The Air Mail maintaining a line running entirely across the continent, making twenty-four flights daily, has operated during the last 18 months without a fatality, and has closely approached perfection in its schedules. Mail planes have left on time and arrived on time in over 95 per cent of their service, notwithstanding flying has been conducted during rainy, foggy and snowy weather.

"Furthermore, those aircraft operating companies which have approximated in their self-imposed regulations the standards adopted by the Air Mail have car-

ried in the last two years more than half a million passengers without a fatality.

"The other side of the picture is not so pleasant. The records for the year 1922 are not yet complete, but in 1921 itinerant or unregulated aircraft operations were responsible, I understand, for 49 deaths, most of which would have been avoided had proper regulatory laws been in force, making inspection and licensing of pilots obligatory. Even this record of unregulated flying is not so dismal when we realize that such flying comprised more than two and one-half million miles, and involved the carrying of nearly 130,000 passengers.

"It speaks well for the ruggedness and stability of American aircraft and the general excellence of our flying personnel when we learn that this record of deaths shows a greater degree of safety than that of the European continental aircraft operations. Our pilots in their haphazard flights were responsible for a lesser number of deaths per passenger-mile than the well-regulated subsidized air lines of Europe.



MR. CHARLES M. SCHWAB

"Our problem is not a difficult one. It is plainly a matter of regulation. An example of this was brought out at the air meet and air races held in Detroit last October, where racing machines under competent control flew approximately 250,000 miles at speeds ranging from 170 to 240 miles an hour without so much as scratching an aviator. Speed in flying in itself I do not feel is dangerous. The real danger lies in defective aircraft, both in the machines and the engines, and undue recklessness and disregard of flying conditions on the part of the pilot.

"To make flying safe the enactment of a Federal law is absolutely essential. Such a law should control the licensing of aircraft, their pilots and the prohibition of 'stunt' flying except in restricted areas during the training of flying personnel. A knowledge of 'stunt' flying I understand, is necessary for pilots, in order that they may properly handle the aircraft, which, for one reason or another, becomes unstable, instability being brought about by air pockets or unusual atmospheric conditions.

"Aviation fits into so many phases of our commercial life, that measures should be taken immediately to regulate and foster its growth and control.

GUY E. TRIPP FORECASTS ENORMOUS ELECTRICAL DEVELOPMENT

When we find every authority unanimous in the opinion that we are on the threshold of the greater electrical era, when we observe by daily contact, when we compare with the recent past, all must believe.

Samuel Insull arrives at his conclusion from a knowledge of actual facts, Thomas Edison is amazed by a visit to Schenectady, Nicola Tesla's imagination now seems concrete, where before it sounded visionary. A. W. Thompson visualizes "Community Betterment" by authorizing an outlay of millions to enlarge the Pittsburgh super-power zone facilities.

These men dream dreams which usually come true.



MR. GUY E. TRIPP

The conception of a great development of electric service in the United States within the next 20 years, comparable to the great national highway arteries that checkerboard the country, as a solution to many economic and industrial problems, was outlined by Gen. Guy E. Tripp of New York, chairman of the board of directors, Westinghouse Electric and Manufacturing Company, in the Duquesne Club last Saturday.

Its consummation would compel the Westinghouse corporation to double its facilities for manufacturing now existent in the Pittsburgh metropolitan district, General Tripp said: "And what is true of my corporation is true of all of the other manufacturers of electrical equipment in the United States.

"It is the objective of the great leaders in light and power throughout the country and that it will become a fact within the next 20 years seems certain, in view of the ever recurring and daily necessity for high tension power."

Cites Road Building.

General Tripp compared these great prospective electrical highways to the country and State roads that

Pittsburgh First.

give birth to the Lincoln and other National highways, educating the country to such needs: "First it was country roads ending in stub ends and lanes that an economic necessity joined together, and later supplemented by others, until the State highways were created. These were inadequate and the National highways came into being.

"Hydro and steam electric power development is in the country road and State highway class today and the need is for 220,000 volt high tension lines bisecting a new continent. These would supply power for transportation lines and all other lines of industry through a series of stations at strategic points from the Pacific to the Atlantic and from the Canadian to the Mexican borders. They would pick up the surplus power of existing local stations and supply them in times of need. They will do away with the great waste in coal and present a maximum saving in this natural resource by using it economically as well as using the great untapped hydro power resources of the country.

California's Example.

"Great things will be done electrically within the next 20 years, and this somewhat idealistic picture I have drawn, which is the objective of the great electrical engineers and leaders of the country, has proved feasible in California, which most nearly approaches the ultimate in high tension electrical power transmission in the country."

ENGLAND IS LOSING GROUND IN INDIAN TRADE

The War Gave Japan an Exceptional Opportunity—German Competition Active and Unscrupulous After the Armistice—Americans Alive and Wellcome.

During the years of war England and her possessions and also the other Allied Powers—with the exception of Japan—were too occupied to be able to maintain their import trade with India. This gave Japan an unique opportunity which, naturally, she was not slow to avail herself of. Japanese goods were exported from Japan to India in large quantities, Japanese representatives poured into the country and a large trade resulted. But by degrees the quality of the goods imported from Japan showed signs of deterioration, dissatisfaction was expressed by both importers and purchasers, so that when peace was declared and other nations freed to devote more attention to commerce they found conditions here peculiarly favorable for resuming, and in some instances for starting, trade. The Americans were first in the field and with their usual "push" and thoroughness they quickly secured a lucrative market for their goods which were and are still imported into India in large quantities. The quality of these imports was good, the prices compared favorably with Japanese goods which—whether merited or not—had become labelled as "shoddy" and consequently the public became good customers of Uncle Sam's. The United States was not allowed for long to have the field to herself, however.

The great continent of Australia with its enormous commercial wealth was seeking fresh markets for its produce. Prior to the war a large and remunerative trade had been done between this country and Germany but this market was now closed. Attention was directed to India: Australian trade representatives visited the country on tours of inspection and enquiry

as to the commercial possibilities and gradually, and to a small extent at first, Australian goods began to make their appearance in the Indian markets. Conditions proving satisfactory, a large and ever-increasing trade sprang up, and now Australia regards, with a considerable degree of justification, India as one of her most lucrative countries for her exports.

Meanwhile Germany was not content to remain an idle spectator of the world's activities, and despite the internal conditions which prevailed in that country her merchants and exporters set about recapturing—and in many instances capturing for the first time—markets for the goods she was able to export. What has so far been the result? An indication of what this activity means in Germany itself is provided by a visit to the port of Hamburg. Eighteen months ago this port was practically deserted, grass was growing on its quays, its machinery was rusting and only about a dozen ships lay in the port. Now all is changed—the port is full of shipping, the quays are being extended, the steam-cranes electrified and work is proceeding night and day. All this means that Germany realizes the possibilities of her export trade and is preparing in no half-hearted manner to meet them.

Her enthusiasm and optimism are bearing fruit overseas. In Java the correspondent of the Federation of British Industries states that German steel goods are rapidly pushing out the British-made article, to which the market is almost entirely closed by reason of the heavy import duties and the adverse balance in the exchange. These features, it is stated, do not so seriously affect the Germans, many of whom now have their works in Holland. The Federated Malay States and the Straits Settlements are also started to be overrun with German travellers who are doing especially good business in cutlery. It is affirmed that many local dealers in these British colonies are buying readily from the Germans provided that the goods supplied are marked either "Made in England" or "Made in the U. S. A."—not a difficult condition for the German traveller to fulfill! Turning to India, we find here, too, the same story of German activity and progress.

Indian Industries and Power, Calcutta.

ISOTOPES

International Table of Values

Atomic Number.—A chemical element is defined by its atomic number, which represents the excess of positive over negative charges in the constitution of the atomic nucleus; theoretically, the atomic number represents also the number of electrons which rotate round the central positive nucleus of the atom. Each atomic number also represents the place occupied by the element in the Mendeleef Table. Of the various methods suggested to determine the atomic numbers, the most important consists in deducing them from the wave-lengths of the high frequency spectra by applying Moseley's law.

Elements (simple and complex). Isotopes.—If the above definition is accepted, each chemical element may be simple or complex, according as its atoms are all of equal mass or not. In the latter case, the element consists of as many isotopes as its atoms have different masses. A complex element is a mixture of isotopes. Three methods (J. J. Thomson, Aston, Dempster)

Chemistry and Industry, London.

have been devised to determine isotopes, the most important being that of Aston.

Notation.—The elements, simple or complex, are represented by the ordinary symbols. To indicate any particular isotope its atomic mass is written as an index to the right of the symbol representing the mixture. The expression "atomic mass" is reserved for isotopes or simple elements considered from the isotopic point of view. The expression atomic weight retains its usual meaning, and is applied to elements without consideration of their isotopic constitution. Thus, Cl³⁵ indicates the isotope of chlorine having an atomic mass 35. This number represents the relative mass of its atom, the atom of oxygen (a simple element) being taken as 16.

Elements Included in the Table.—The isotopes of lead which are the ultimate result of disintegration of radioactive elements, and the radioactive isotopes will only appear in the International Table of the radioactive elements. Only those elements appear in the Table of Isotopes which are recognized as simple, or are complex elements whose isotopes have been determined with sufficient certainty.

Provisional Values.—Numbers in brackets are to be taken as provisional only.

TABLE OF ISOTOPES

Element	Atomic no.	Atomic weight (1)	Masses of isotopes (2)	Accuracy %
H	1	1.008	1.008	.02
He	2	4.00	4	0.2
Li	3	6.94	7; 6	
Gl	4	9.1	9	
B	5	10.9	11; 10	0.1
C	6	12.005	12	0.2
N	7	14.008	14	0.2
O	8	16.000	16	
F	9	19.0	19	0.1
Ne	10	20.2	20; 22	0.1
Na	11	23.00	23	
Mg	12	24.32	24; 25; 26	
Al	13	27.0	27	
Si	14	28.1	28; 29; (30)	0.1
P	15	31.04	31	0.2
S	16	32.06	32	0.2
Cl	17	35.46	35; 37	0.1
A	18	39.9	40; 36	0.1
K	19	39.10	39; 41	
Ca	20	40.07	40; (44)	
Fe	26	55.84	56; (54)?	
Ni	28	58.68	58; 60	0.1
Zn	30	65.37	64; 66; 68; 70	
As	33	74.96	75	0.1
Se	34	79.2	80; 78; 76; 82; 77; 74	0.1
Br	35	79.92	79; 81	0.1
Kr	36	82.92	84; 86; 82; 83; 80; 78	0.1
Rb	37	85.45	85; 87	
Sn	50	118.7	120; 118; 116; 124; 119; 117; 122; (121)	
I	53	126.92	127	0.2
Xe	54	130.2	129; 132; 131; 134; 136; 128; 130; (126); (124)	0.1
Cs	55	132.81	133	
Hg	80	200.6	(197-200); 202; 204	0.1

Burning Blast Furnace Gas

The Problem Presents More Different Elements Than Any Other Type of Fuel—Classification of Burners—Details of a Number of Tests.

By GRANT D. BRADSHAW*

THE combustion of blast furnace gas under boilers is essentially different from the use of any other fuel. Not only is the heat value low per cubic foot, but the gas must be used as it is generated in the blast furnace. The investment cost of providing storage of any adequate capacity would be altogether too great to be seriously considered. Another difference between this gas and other gases is the dirt which accompanies it. This dirt precludes entirely the utilization of any burners having small gas orifices in which there is any possibility of the dirt settling.

A satisfactory burner must, therefore, not only be simple in design in order to be practically self cleaning,

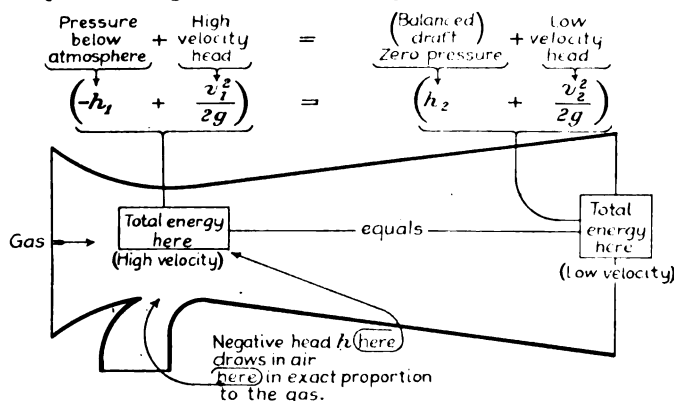


FIG. 1—Principles of burner design.

but must be so designed that the fluctuation in gas quantity which varies from minute to minute will control proportionally the quantity of air for combustion. This variation in air quantity must be automatic, as any attempt to control it by hand would require a man to each burner, if it were to be accomplished at all efficiently.

Burners now generally used can be divided into several classes:

(a) The old fashioned "goose neck" burner in which the air is drawn in almost entirely by stack draft. This burner is responsible for the general inefficiency of blast furnace gas combustion in many older plants at the present time. When depending upon stack draft to pull in the air the air quantity will be *inversely* proportional to the gas flow, which is just the opposite of what is desired. As the gas quantity to the boilers suddenly increases the draft in the combustion chamber *decreases*, resulting in *less* air being pulled in. Naturally, inefficient combustion is the result. These installations are gradually being replaced by modern burners. Where a combined blast furnace and steel plant is using fuel for steam generation in addition to that produced by the waste gas, the saving of from \$50,000 to \$80,000 per year per furnace, simply by the installation of efficient burners, is beginning to look very attractive.

*Andrews-Bradshaw Company, Pittsburgh, Pa.

(b) Burners where part of the air is aspirated by the gas, but which still depend to some extent on the stack draft for supplying sufficient air. These burners are a big improvement over the "goose neck" type, but still leave a great deal to be desired.

The range of pressure over which they will operate efficiently without hand adjustment is small, and when they backfire they require immediate adjustment to get the flame out beyond the burner nose.

(c) Burners designed to aspirate the entire quantity of air by means of gas velocity. This type of burner gives high efficiencies than it is possible to approach with either of the others. The diagram in Fig. 1 shows the principle upon which full aspiration can be obtained. It will be noted that the lower the outlet velocities are kept the more nearly will the burner approach perfection. At the same time it should be noted that inasmuch as the energy in the gas itself is used to pull in the air, that any eddy currents or friction losses should be avoided. For this reason, to obtain the best results the modern burner is designed with a uniformly expanding mixing cone, and the inside surface is smooth finished rather than a rough casting.

One of the large steel companies made a test on some burners of this type which is of interest as showing the high efficiency which can be obtained with proper burner design.

Duration of trial—hours.....	21
Calorific value of gas—Btu. per cu. ft.....	92.31
Average gas main pressure—inches.....	2.147
Average gas press. up river burner—inches.....	1.06
Average gas press. down river burner—inches.....	1.19
Average gauge steam pressure—lbs.....	128.65
Average gas temperature to boiler—Deg. F.....	380
Average temperature of feed water—Deg. F.....	114
Average temperature of waste gases—Deg. F.....	534
Average draft in third pass—ins.....	.440
Average moisture in steam—per cent.....	1.2
Average boiler hp. developed—per cent.....	528.1
Average analysis of third pass gas CO ₂ —per cent....	21.74
O—per cent....	2.66
CO—per cent....	.14
N—per cent....	75.46
Average stack loss—per cent.....	14.0
Average radiation loss (assumed)—per cent.....	5.0
Average total loss—per cent.....	19.0
Boiler efficiency—per cent.....	81.00
Type of boiler—500 hp. Babcock & Wilcox.	

Fig. 3 shows a CO₂ recorder chart, taken at another plant, in the rear pass of a B & W boiler compared with the chart of gas pressure on the burners during a typical 24-hour period. This was on a single furnace plant and the casting periods can be seen plainly, at which time, of course, there was practically no gas whatsoever. The drop between 9 and 38 at night was the period of combustion chamber cleaning when the front doors were open. The slight drop at 8:30 in the morning was the time at which the tubes were blown with a steam lance. The entire boiler house at which these charts were made

was equipped with the type of burner giving full air aspiration. The test in Fig. 3 shows an efficiency of over 78 per cent. This compares with previous efficiencies of between 50 and 60 per cent on the same boilers when they were equipped with the old fashioned "goose neck" burner.

It is interesting to note that while the charts shown in Fig. 2 were made a number of years ago, and indicate an efficiency of over 80 per cent, tests were made recently to determine whether this original performance was being maintained. Such tests made over a six-hour period with a range in gas pressures of from $1\frac{1}{8}$ in. up to $2\frac{1}{4}$ in. without burner adjustment showed an efficiency of 80.8 per cent.

(d) Pressure type burners have been installed in a few plants, and when properly designed, installed and controlled, give very good results. These burners are divided into two classes. First, those which have a fixed gas area and in which the variable gas quantity produces a variable gas pressure. This pressure is utilized to control the speed of fans supplying air under pressure to the burners. Second, those in which the area of the gas and air throats is made variable and is controlled by the gas quantity.

This latter type has one additional feature which is of note: it will permit of closer stove regulation and therefore more gas available at the boilers. Due to the fact that the gas throat is varied directly proportional to the gas quantity a constant gas pressure is automatically maintained in the mains. As the gas quantity increases, the gas passages open up, keeping the pressure normal, and as the gas quantity decreases these gas passages close and in this way hold the pressure and protect the stoves at all times. This makes the entire boiler house operate as a gigantic relief valve, taking the surplus gas at all times.

The stoves require a comparatively constant amount of heat, and inasmuch as stove operation is absolutely necessary to proper blast furnace operation, the stoves should have a preference at all times. With ordinary fluctuating gas pressure it is usual to carry more gas on the stoves than is really needed, in order that at times of light gas flows the stoves will not be robbed by the boilers. The *constant pressure type* of pressure burner, shown in Fig. 4, not only insures gas at all times for the stoves, but also makes available for boiler use that gas which, due to a desire to protect the stoves against low gas pressures, was formerly wasted.

However, pressure type burners require expensive blowing equipment to provide air under pressure, and at present under most conditions it is hard to see how, with the results being obtained by the aspirating type burner, this additional investment and continual power cost is justified. With a *constant pressure type* of pressure burner (as differentiated from the fluctuating pressure type) there is a possibility of utilizing the additional gas, which is now wasted at the stoves, and burning it under the boilers. On this basis the additional complications might, under certain conditions, be justified.

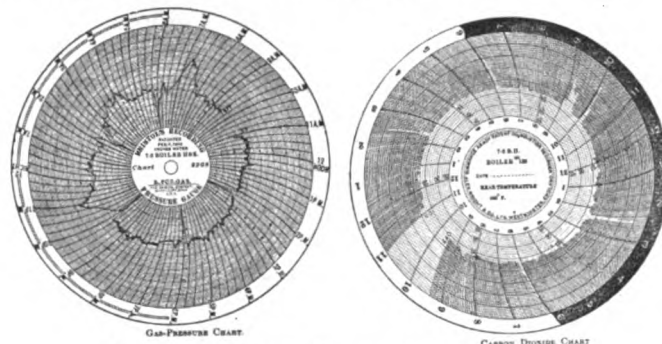
A discussion of burners would not be complete without a discussion of the theory of proper mixing of gas and air.

There seems to be a widespread misapprehension as to the reasons underlying the intimate mixing of two gases. With gases, as with water, there is a certain critical mixing velocity below which they will not mix intimately, no matter how finely the streams are divided. If the velocities are below this point, even though the gas stream is interlarded with streams of air, the mixture

will not be intimate and a long flame will result. On the other hand, above this velocity two parallel streams of gas and air cannot be prevented from mixing intimately, and consequently giving the desired short, snappy flame.

Thus it will be seen that complicated burner castings, which attempt mechanically to split up air and gas streams to obtain mixing, are entirely unnecessary. This is of considerable advantage with dirty gas.

One of the principal results in maintaining correct air to gas ratios by means of proper burner design is the



FIGS. 2 AND 3—Comparative CO₂ charts.

increase in combustion chamber temperatures. Instead of temperatures of 1800 and 1900 deg. F., which are as high as can be expected, with the older type burners, the modern burners now are responsible for temperatures of from 2200 to 2300 deg. F. The effect of this increased temperature is very marked, and results in a considerable lowering of the stack temperatures.

A rise in temperature of even 200 deg. increases the transfer of heat by radiation in the first pass to a very marked degree. This is, of course, plain when it is remembered that transfer of heat by radiation is proportional to the difference of the fourth powers of the absolute temperatures. The additional heat absorbed, therefore, in the first pass results actually in a decided decrease in stack temperatures and a corresponding increase in boiler efficiencies.

Summary.

The general tendency this last year has been to recognize the almost criminal waste of blast furnace gas, which is common practice with many steel plants that are otherwise up-to-date. When it is realized that proper burner equipment will usually produce 20 to even 30 per cent more steam than the old fashioned burners, this tendency will be increased, and it is hoped that the old fashioned burners will be entirely eliminated in the next few years. Whether aspirating burners or pressure burners of the constant gas pressure type are installed resolves itself into a question of efficiency vs. cost of operation and first cost. With the present cost of coal, which determines the economical value of blast furnace gas, it is hardly felt that, as yet, the additional horsepower which might be developed by the elaborate installation of the constant pressure type of pressure burners is warranted. As the cost of coal increases in future years the pressure burner, however, may become an increasing factor in the combustion of blast furnace gas.

Burners for Coke Oven Gas.

Coke oven gas has become of more importance in steel works operation during the past year, and the demand for a burner which will satisfactorily handle this difficult gas is increasing.

The aspirating type of burner, similar to that used in

blast furnace practice, is not applicable to coke oven gas. This gas is more than half hydrogen, and the explosive reaction and quick expansion of the products of combustion are in marked contrast to blast furnace gas. Where large aspirating burners have been tried, the hydrogen content of the gas has been found to burn at the throat. If outlet velocities are increased to prevent partial burning at the throat the aspirating effect is almost entirely lost, as the principle of drawing in air to a burner by

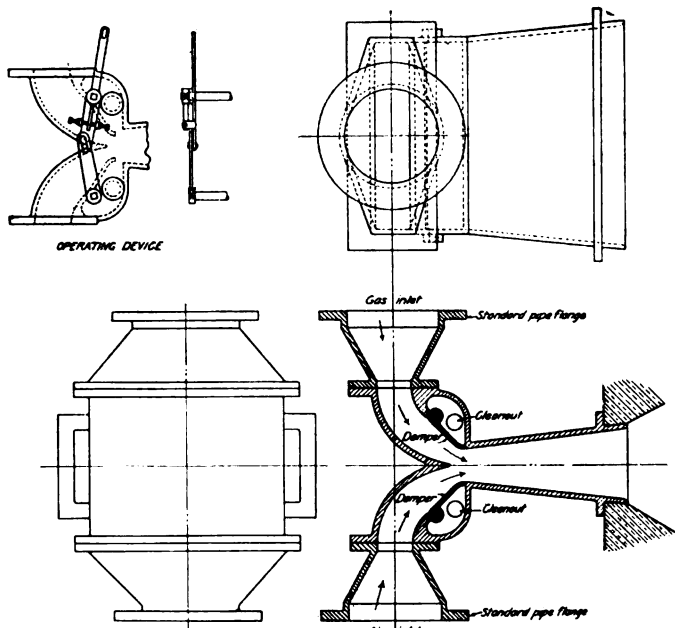


FIG. 4—Pressure type B. F. G. burner.

aspiration depends on *low outlet velocities*. It is, therefore, apparent that contracting the outlet, or in other words, installing a "nosepiece" on a burner, would in itself defeat the object in view. Also such a burner would backfire badly, and, even with a high draft in the combustion chamber to pull in the air, would require constant attention. To avoid these difficulties a burner similar to that shown in Fig. 5 has been designed, where the burner plate is made either water cooled or of carborundum. This design avoids the difficulties experienced by the larger aspirating burners, and while it depends to some extent on stack draft, makes a very satisfactory installation.

The best method of handling coke oven gas, however, appears to be the pressure type burner shown in Fig. 4. By maintaining a suitable air pressure and holding this air pressure constant by means of a pressure regulator, high velocities can be maintained in the burner well above the explosive reaction of hydrogen. Of course, the gas pressure to the burner is maintained constant by means of a reducing valve. When this burner is once set with the proper ratio of air to gas this ratio is maintained over the entire range of capacity, and the velocities, being high, burning at the throat is entirely prevented, and with the expanding nose, which is also used, backfiring is absolutely impossible.

Burners for Pulverized Coal.

While progress has been made during the last year in the burning of pulverized coal, there is much to be desired from the standpoint of an efficient burner design.

From a consideration of burner and boiler efficiency alone the matter appears fairly simple; unfortunately, it is complicated by other practical considerations that are

too serious to be ignored. The first consideration requires the maximum combustion chamber temperature with complete combustion before the products reach the heating surface. This, of course, is the general aim of all burners for all kinds of gases, and seems absurdly simple. When these principles are applied to powdered coal the temperatures reached by the release of such a great number of Btu. in a relatively small space are so high that, combined with the fluxing effect of the ash, they ruin any firebrick with which the furnace can be lined.

The problem, therefore, resolves itself into a combination of burner design in its relation to volume and

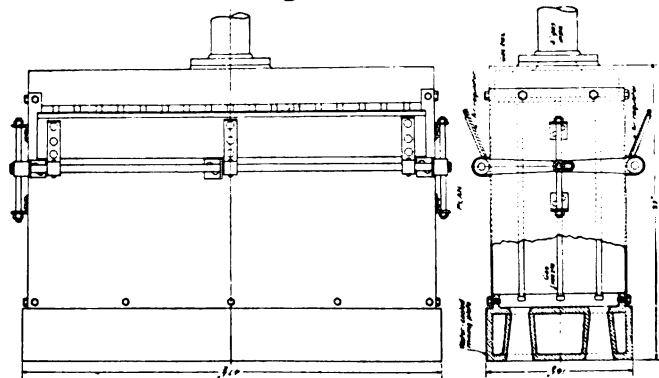


FIG. 5—Recent design pressure burner.

proportions of the combustion chamber together with the arrangement of heating surface, so that the best air to fuel ratios may be maintained without reaching temperatures destructive to brickwork, and without allowing the finely divided ash to come into contact with the hot refractories.

The recognition of these principles is indicated in present practice by the increasing size of combustion chambers; by the practice of placing the fuel inlet in the furnace roof to avoid the effect of the ash on an extremely hot arch; by admitting only a small part of the air for complete combustion with the fuel itself, the remainder being introduced at intervals through holes in the front wall. This latter design tends to release the heat from the powdered coal progressively over a greater length of combustion chamber.

While progress has been made there is still a large field open for design and experiment, and it will probably be several years before general design will even approach what might be termed a standardization of practice.

STATEMENT OF OWNERSHIP, MANAGEMENT, ETC.

The Blast Furnace and Steel Plant

[Required by Act of Congress of August 24, 1912]

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L. L. CARSON, Business Manager.

Sworn to and subscribed before me this 20th day of March, 1923.

CHAS. A. SEIBERT, Notary Public.

(My commission expires March 6, 1927.)

Methods of Ash Handling*

Raising Boilers to More Liberal Heights and Provision for Broad-Gauge Car Placements Underneath Have Simplified the Problem—Improved Combustion Has Reduced Volume Necessary to Handle.

PART II

By JOHN HUNTER† and ALFRED COTTON‡

(The necessary elimination of Figs. 15, 16 and 17 causes a slight rearrangement of the original copy, but these changes interfere in no way with the completeness of the discussion.)

OWING to the abrasive nature of ash, the maintenance cost of mechanical conveyors is high. The ashes grind away the connecting pins, and even with regular renewals the pins sometimes wear excessively and cause breakdowns.

The life of these conveyors is considered to be about seven or eight years, and extensive repairs must be made every two or three years. The excessive cost of maintenance has led to their replacement in some installations with electrically operated cars carrying the ashes to outside pits from which they are loaded into railroad cars with a bridge crane, and the cost of handling has been reduced 50 per cent.

Hopper ashpits with large doors should not be dumped directly on to chain or bucket conveyors. With direct

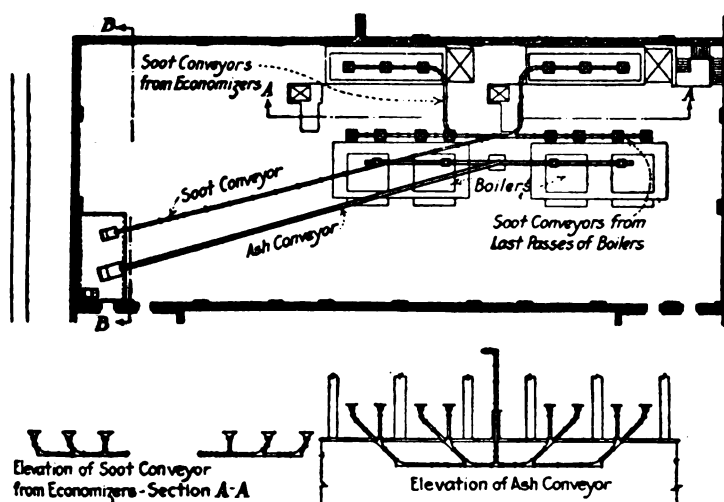


FIG. 18—Air conveyor at Milwaukee sewage-disposal power plant. Plan.

*Contributed by the Materials Handling Division and presented at the Annual Meeting, New York, December 4-7, 1922, of the American Society of Mechanical Engineers. Abridged.

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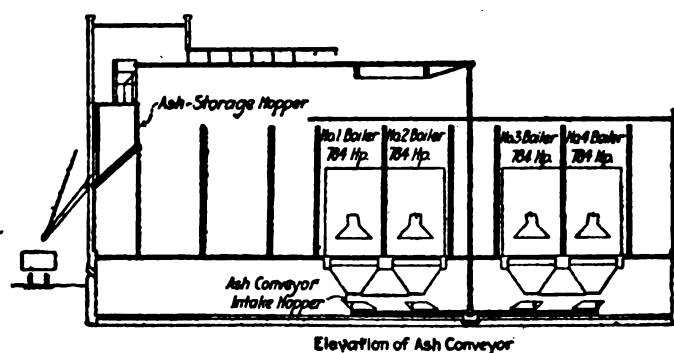


FIG. 19—Air conveyor at Milwaukee sewage-disposal plant. Elevation.

dumping, large clinkers are liable to jam and cause breakdown, and opportunity should be given for breaking them.

The Fisk Street and Quarry Street stations of the Commonwealth Edison Company of Chicago are each equipped with bucket conveyors which handle both coal and ashes. There is an additional pair of ash conveyors at Quarry Street which carry the ashes to the train shed. The electrically operated ash cars now used in place of the apron conveyors formerly employed are dumped into a pit outside the building. A bridge crane takes the ashes from the pit with a grab bucket and loads them into railroad cars. The cost of maintenance as compared with the apron conveyors is almost negligible. The outside pit and crane were originally installed for and used with the apron conveyor.

At Northwest and Calumet stations, Chicago, the ash is dumped from hopper ashpits directly into railroad cars. The only maintenance required is upkeep of ashpit linings and dumping doors. The cost of the ash handling system at these stations cannot well be estimated because there is none.

An example of a simple chain and cross bar conveyor is illustrated in Figs. 1 and 2. The conveyor installed at one of the municipal plants of the Poplar Borough Council in England and illustrated in Fig. 16, may be considered as a development of this idea in combination with the water seal of Fig. 10, though there is no ashpit storage. In fact, there is no ashpit, only sheet-

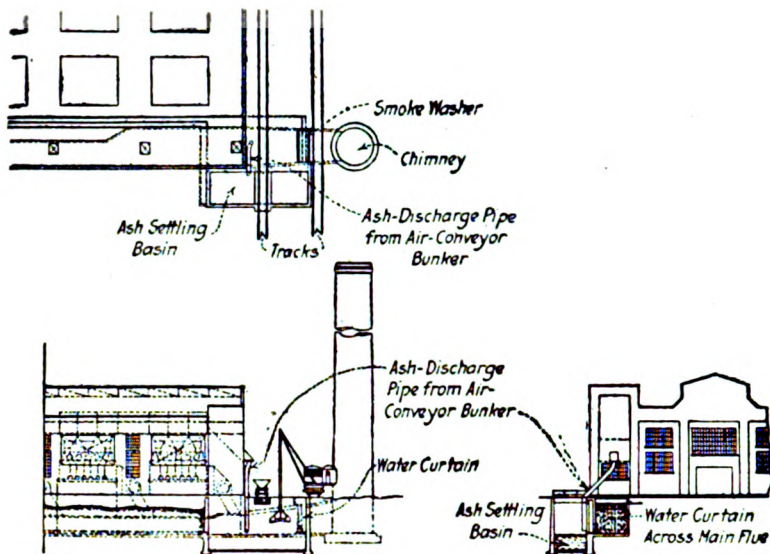


FIG. 20—Air conveyor and smoke washer for pulverized coal firing at Lakeside Station, Milwaukee.

steel unlined chutes ending in cast iron nozzles which dip below the water level in the conveyor trough, thus providing the water seal. The return of the chain is also below the surface of the water. The transverse centers of the chain are $19\frac{1}{2}$ in. apart and the cross bars are $25\frac{1}{2}$ in. pitch. Therefore large clinkers easily fall between the upper run of the chains and cross bars to the bottom of the trough. The end of the trough is carried upward at an angle of 41° to its discharge into the ash bin, from which the ash is recovered by grab bucket.

No ash crushers are necessary as the space between chains and cross bars is sufficient to allow large clinkers to fall through the upper run of the chain into the water; and the hot clinkers break upon falling into the water, the average size as delivered from the conveyor being about equal to that of a pea.

The length of this conveyor is about 140 ft. and it is designed for a chain speed of 20 ft. per min. One conveyor running at 9.5 ft. per min. and handling 3.25 tons of ashes per hour takes a little under 2 hp.

Air Conveyors.

Air is passed through a pipe at a sufficiently high velocity to carry the ashes along with it. The air is admitted at one end and ash intakes are provided wherever required. There are two systems of generating the air current. In one, the pipe outlet is connected to an ash storage tank in which a vacuum is caused by means of a steam-jet or mechanical exhauster. In the other, the air current is induced by a steam jet between the ash intakes and the outlet.

A typical layout of an air conveyor with vacuum storage tank is illustrated in Fig. 17. A steam jet exhauster is attached to the top of the tank and may discharge into the atmosphere or into the chimney or a silencer to reduce the noise. It is claimed that ordinary gray-iron piping may be used, and a test is offered wherein a piece of conveyor pipe was replaced with a light wrought-iron pipe which showed but little wear after a year's service carrying 5,000 tons of ash.

An ash tank is not required as a part of the system. It is usual for the conveyor to discharge

into an elevated ash tank supported on columns, so that carts, motor trucks, or railroad cars may be run underneath the tank and be filled quickly by opening the ash valve in the bottom.

The ash particles may momentarily attain velocities approximating to that of the steam jet at a little distance from the muzzle of the nozzle, and therefore local abrasion may be considerable. It is usual to locate the motor jet at an elbow, as it is then convenient to aim the jet in the new direction. When the conveyor pipe is very long, extra nozzles are installed in some cases. When the nozzles are arranged in straight pipe they are set at an angle to the axis of the pipe and are then not so efficient as they would be if coaxial. An air inlet is provided at the beginning of the pipe, for it must be remembered that it is the velocity of a large body of air which carries the ash, and not the vacuum.

As an instance of the speed at which ashes can be handled, a plant may be cited containing fifteen 500-hp. boilers equipped with Murphy stokers, where the average amount of ashes in each pit ranges from 1,000 to 1,300 lbs. One man cleaned out eight ashpits in 27 min. from the time steam was turned on until it was turned off.

Some stokers are provided with clinker crushers, and when this is not the case it is becoming increasingly necessary to add clinker crushers as part of the ash-handling equipment, so that the clinkers may be reduced to such size as the conveyors can handle without choking or breakdown.

The maximum capacity of a 6-in. conveyor is about four tons of ash per hour; that of the 8-in. 6 to 9 tons; and of a 9-in. conveyor, 10 to 15 tons and even 20 tons in some cases. The capacity depends largely upon the size of the pieces. Ash should not be wet or quenched when fed to an air conveyor. Ashes can be conveyed by air conveyors through a horizontal distance of about 500 ft. and through a rise of about 100 ft.

The cast iron used for pipes and elbows and other fittings is generally made of the hardest possible white iron, such as is not machinable and can only be ground, so that connections are commonly made by means of bolts

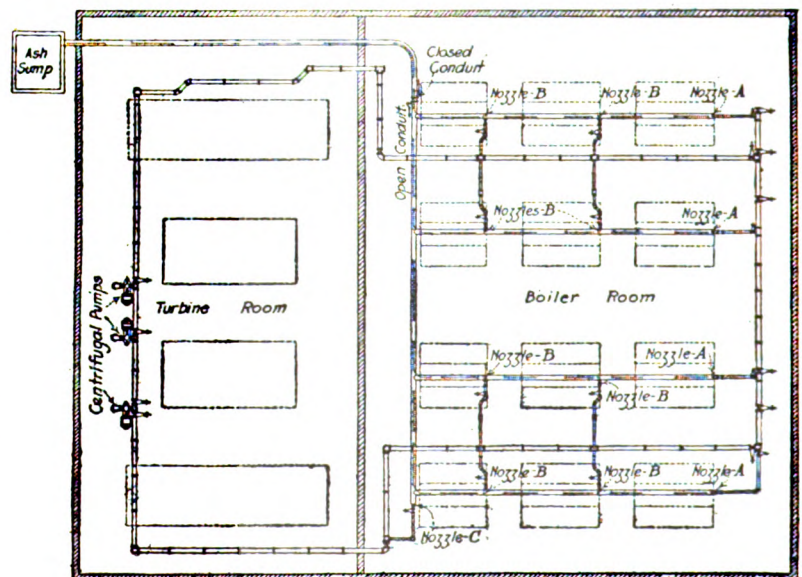


FIG. 21—Water conveyor at Hell Gate Station. Plan.

slide into open lugs. The wear is greatest at elbows where the ash direction is changed, and it is usual to provide "wearing backs" of easily replaceable blocks.

Air conveyors use a large quantity of steam while running, but as they remove the ash very rapidly, the cost of steam per ton of ash removed is quite small when they are properly operated.

Considerable expense ensues if steam nozzles are allowed to wear excessively before renewal. Not only is the steam consumption greatly augmented, but the in-

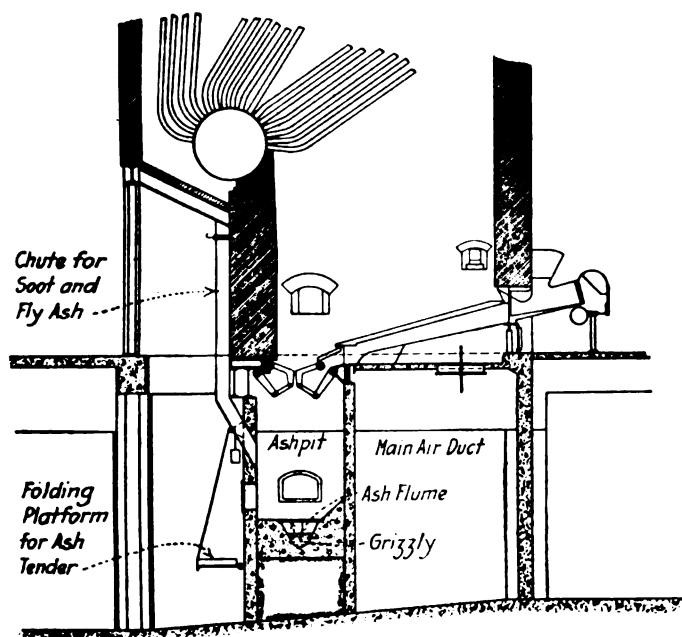


FIG. 22—Water conveyor at Lacombe Station, Denver.
Cross sectional elevation.

creased energy of the larger steam jet results in higher air and ash velocities with greater wear of pipes, elbows, targets, etc. Such wear of steam nozzles is greatest with wet steam.

In some instances the steam jet conveyor is objectionable because the steam used represents so much water lost, and which must be replaced by "make-up." It is becoming increasingly general practice to distill all make-up water so as to prevent any scale forming or foam making salts from getting into the boilers. Condenser leakage is diligently looked for and eliminated. Therefore, owing to the care with which pure water must be conserved, it is obvious that any apparatus which removes water from the system, such as steam jets whose steam does not eventually reach the condenser, will usually be frowned upon by operating engineers.

One ton of steam will move four to eight tons of ash. With a coal containing 12 per cent of ash, two tons of steam would be used per 10 tons of coal. Taking an average evaporation of 9 lbs. of water per pound of coal, the conveyor would use two tons of steam out of each 900 tons generated, or nearly 0.2 per cent. To allow for careless operation or negligent maintenance and other contingencies, it would perhaps be advisable to allow, say, 0.3 or 0.4 per cent in arranging for extra distillation for make-up.

Air conveyors generally result in clean basements or firing floors because there is less spillage. The first cost is usually lower than that of a mechanical system, they take up very little space and can be installed in awkward

positions, and require very little attention; but this is not always a good feature unless periodical inspection is conscientious, because steam nozzles may wear and leaks due to abrasion of pipes develop, and these may result in considerable waste of steam. The very convenience of the method may develop carelessness in allowing the steam to blow when ash is not being fed. It is safe to operate because there are no moving parts and this feature makes for small expense of putting in renewals.

The air conveyors which are being installed by the Conveyor Corporation of America at the New Milwaukee sewage plant are illustrated in Figs. 18 and 19. The plan in Fig. 18 shows the ash conveyor, which has a bore of 9 in., in conjunction with the four 734-hp. stoker fired boilers. The hopper ashpits are dumped into auxiliary hoppers formed about the conveyor intakes, as will be seen in Fig. 19. This permits of rapid feeding of the conveyor without smothering it. It is to convey a minimum of 12 tons per hour, with a steam consumption not exceeding 325 lbs. of steam per ton of ashes.

The conveyor for soot and fly ash is independent of the ash conveyor and has a bore of 6 in. This arrangement usually increases both the capacity and the efficiency over that obtained with combination conveyors. It is connected to the later boiler passes and to the economizer, and discharges into a separate target box set upon the top of the ash bunker.

The installation at the Lakeside plant of the Milwaukee Electric Railway & Light Company is of consider-

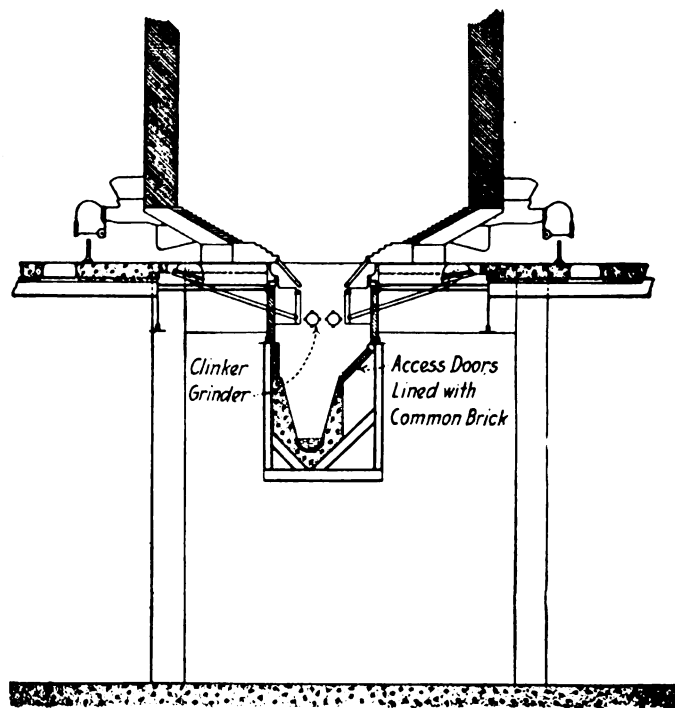


FIG. 23—Water conveyor at Hell Gate Station.
Cross sectional elevation.

able interest because the boilers are fired with pulverized coal. (See Fig. 20.) There are eight boilers of 1,333 hp. each—1,306 hp. in the boiler proper and 27 hp. in the form of a water screen at the bottom of the combustion chamber. This water screen entirely prevents the formation of clinker or slag which was so troublesome in some of the earlier powdered coal installations. Instead, the ash from the combustion chamber is a fine powder which is very easily handled by an air conveyor.

The air conveyors were installed by the Vacuum Ash & Soot Conveyor Company, have been in successful operation nearly two years, and practically no maintenance work has been required during that time; only one nozzle has been replaced.

To recover some of the fine ash which would otherwise be discharged from the chimney top, a smoke washer is installed in the main flue about 20 feet before it enters the base of the stack. It consists of two 4-in. pipes placed parallel to each other in the top of the flue. These pipes are provided with nozzles of $\frac{1}{4}$ -in. pipe 1 in. long placed at 3-in. centers along each pipe, the nozzles of one pipe being staggered relatively to those of the other. The pipes are supplied with about 350 gal. of water per min. at a pressure of about 6 lbs. per sq. in. The jets from the nozzles form a water curtain through which the gases must pass before entering the chimney. Actual tests show that 50 per cent of the ash suspended in the flue gases is removed by this apparatus.

The boilers are arranged in two rows of four each, facing each other across the firing aisle. There are two conveyors, the main line of each being in the floor of the ash alley in front of the furnace ashpits. Each main line takes care of four boilers. Branch lines lead to the ash chambers at rear of the boilers and also to the ashpits under the economizers.

All the conveyor lines are of 8-in. cast iron pipe. The running length of the two main lines is approximately 200 ft. with a vertical rise of 65 ft. The lines from the ash chambers and the economizer ash hoppers are approximately 190 ft. long and have a vertical rise of 50 ft.

Ash Bunkers.

Considerable choice of materials and design of ash bins and supports is available. A large number, perhaps most, are made of reinforced concrete. In some cases they are inside the boiler room and worked into the general design of coal bunkers, etc., such as illustrated in Fig. 14. They are occasionally built so as to span an alley, being supported by the buildings on each side.

Ash bunkers have also been built of brick, but unless very thick walls are used, they should either be buck-stayed or have reinforcing bands laid up every five or six courses. The bricks should be hard and well burned, and laid in cement. The inner face of the walls should be of paving brick.

Hollow tile ash tanks have several inherent advantages in that they are fireproof, prevent freezing of wet ash, are acidproof, provide space for steel reinforcing

rings within the wall, and have a smooth interior surface. The tiles are laid up in cement and are provided with key grooves on their joint faces.

Tanks may also be made up of a cast iron skeleton filled in with cast iron plates, the whole carried on a structural steel framework. Cast iron, being much less subject to corrosion than steel, makes a durable tank for ash storage.

Water Conveyors.

In systems of water conveyance the conduits carrying water are largely or wholly open. With a plentiful supply of water, this method has much to recommend it. There is no dust or heat and the ashes are carried away very quickly. Owing to the low velocity of the vehicle as compared with air, the wear is very small and usually is not troublesome. The conveyance, of course, must always be down hill when open flumes are used, and a grade of 3 or even 4 per cent is desirable.

Where a natural supply of water from an elevator is not available, a centrifugal pump may be used. The Hell Gate plant is an excellent instance of this kind, and the general layout is shown in Fig. 21. This is a system of open flumes within the boiler room continuing through a closed pipe to the ash setting tank. Tributary flumes are carried along below each line of boilers and empty into a main cross flume which runs along the boiler room wall near the turbine room. This main flume then turns and becomes a full pipe or enclosed conduit leading to a pit near the river side into which it discharges. The ashes are recovered from this pit by a grab bucket operated by a locomotive crane running on a track laid on the pier, and discharged into scows. The scows are towed out and dumped at sea about five miles east of Sandy Hook, or about 30 miles from the plant.

The flumes within the boiler room are of concrete with a bottom lining of vitrified earthen drain tiles or half pipes. Those under the boilers are supported on structural steel framework suspended from the firing floor, while the main cross flume is carried on steel trestling.

A cross section of the flume under the boilers is shown in Fig. 23. The ash as it leaves the clinker grinders drops directly into the water and is carried away. Access doors lined with common brick are provided so that any obstruction can be handled easily. These doors may be seen in Fig. 23.

The method of water supply is very interesting. There is a nozzle *A* at the head of each tributary flume, and an ingeniously arranged undercurrent nozzle *B* at the beginning of each succeeding ashpit. These undercurrent nozzles are at the bottom of the flume and are arranged to discharge horizontally downstream. They are placed to form steps in the flume so that the ash flows over them. At the head of the main conduit is a booster nozzle *C*.

The water for the various nozzles is taken from the circulating discharge tunnel and is supplied under pressure by 12-in. Lea-Courtenay centrifugal pumps direct driven by 150-hp. Westinghouse motors. These pumps supply 5,000 gal. per min. against a head of 75 ft., operating at 81.5 per cent efficiency.

The main pipe line which supplies the water nozzles has a bore of 16 in. and is arranged as a ring as clearly shown in Fig. 21.

Fig. 22 shows a cross section of the flume under the boilers of the Lacombe station of the Denver

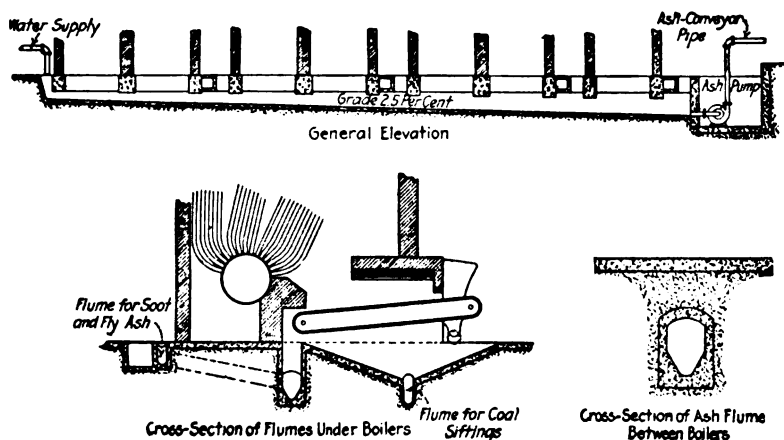


FIG. 24—Morrison's water conveyor at Great Western Sugar Refinery, Denver.

Gas & Electric Light Company. The outstanding difference between this plant and the one at the Hell Gate station is that there are no clinker grinders. As a result, the flumes are protected by a "grizzly" composed of heavy bars set 6 in. center to center to withstand breaking up the large clinkers until they can drop between the bars into the flume. The water stream will easily handle clinkers about 12 in. square and 15 lbs. in weight.

Water sprays cool the clinkers which are caught on the grizzly. Side-hinged doors 18 in. by 23 in. are provided through which the clinkers can be managed.

The station contains five boilers of 750 hp. each, operated at 250 to 300 per cent of rating. The coal is a sub-bituminous containing 6 to 7 per cent of ash. As the boilers are in line, the flume is single and straight. It is all of 2 per cent grade except the curve to the ash-settling tank, which is of 18-in. vitrified sewer pipe laid horizontally. The flume and sewer pipe is about 155 ft. total length. The capacity of the settling tank is 3,000 cu. ft.

The water passes through a screen and is recirculated, and a 2-in. line is used to replenish occasionally the water in the system. The water is circulated by a 6-in. American open runner centrifugal pump driven by a 20-hp. motor. The pump delivers about 1,100 gal. per min. against a head of 25 ft. The system deals with about 33 tons of ashes in 24 hours.

An ingenious arrangement is that invented and patented by Mr. Morrison, of the Great Western Sugar Company of Denver, and installed in several of their plants. An example is partly illustrated in Fig. 24. A flume into which the ashes are fed is arranged under the boilers as in other water conveyors. This flume carries the ash-laden water into the suction connection of a centrifugal pump which discharges into the conveyor pipe. The conveyor pipe is of cast iron, 6 in. bore. Abrasion occurs slowly, but is confined to the bottom of the pipe. It is found that by rotating the conveyor pipes through an angle of 90 deg. every few years, maximum service is obtained out of each renewal.

In designing a water conveyor it must be borne in mind that while continuous dumping stokers such as chain grates or those equipped with clinker grinders may discharge directly into continuously running water, dumping stokers or any firing system where large clinkers are to be expected should discharge on to a grizzly of massive bars on which clinkers may be broken small. The water need only be running while dumping is in progress with stokers of the dumping type.

Concrete troughs, if carefully built, will be found to require very little repair. The inside lining should be smooth and free from pits. There should be a plentiful supply of water under a few pounds pressure. About 1,000 gal. per min. should be supplied for each flume.

With natural draft, means should be devised to provide seals so as to prevent too great an excess of air from passing up through stoker dumps.

When the water is recirculated, the pump should be designed to handle gritty water, and occasional renewals due to this reason must be expected, though they will not be serious.

As there is often considerable dust and gas generated with stokers of the dumping type, it is advisable to provide the access doors with latches so that they cannot be blown open. Ample ventilation near where the ashes are handled should always be provided.

In some localities in winter, trouble may be expected from water freezing in the bearings of grab buckets. In particularly cold situations the wet ash will freeze in the cars and cannot be dumped unless it is thawed out. Weather conditions may therefore prohibit water conveyors in some instances.

STEINMETZ TO LECTURE BEFORE ENGINEERS OF STEEL INDUSTRY



Dr. C. P. Steinmetz, the wizard of electricity, who has perhaps accomplished more in electricity than any other man in history, will lecture to the engineers of the steel industry under the auspices of the A. I. & S. E. E. on Thursday, April 12, 1923.

A physical dwarf—an intellectual giant, the genius who has mastered the secret of the thunderbolt, will explain how modern science has diagnosed the action of lightning by a staggering feat of mental and mechanical ingenuity, which included the piecing together of the thousand fragments of a shattered mirror.

This modern jove sits on his throne and hurls thunderbolts which leap about in his lightning arsenal working destruction. His experiments have produced indoor thunderstorms, lightning without clouds, but lightning nevertheless.

The laboratory lightning does everything that nature's lightning does, behaves the same way, has the same characteristics, on a smaller scale, of course. But nature has no hand in it. She is literally on the outside looking in.

Dr. Steinmetz estimates the voltage of the lightning flash of a real thunderstorm at 50,000,000 volts. The artificial lightning represents, while it lasts, more than a million horsepower. The estimated horsepower of a natural lightning flash is estimated at 500,000,000 horsepower.

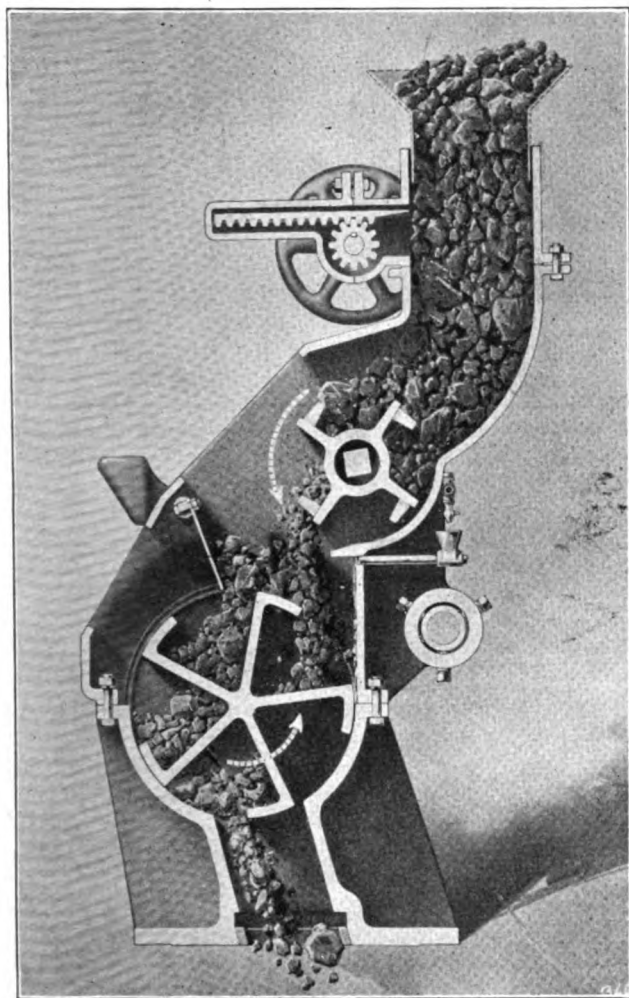
Dr. Steinmetz came to this country as a boy—a fugitive from Germany, without money or friends. Today, he is perhaps the best known scientist in the world.

The lecture will be preceded by a dinner, both at the Wm. Penn Hotel in Pittsburgh.

WITH THE EQUIPMENT MANUFACTURERS

Under title "W-S-M Gas Producer Type L, No. 8," the Wellman-Seaver-Morgan Company of Cleveland are issuing an illustrated bulletin describing in detail their newly developed heavy duty mechanical gas producer.

The 18 years of manufacturing and operating experience, with the Hughes Producer, during which period over 1200



Automatic feeder.

machines have been installed have resulted in many practical improvements. These have been incorporated in this new producer.

1. It is self-contained.
2. It is entirely automatic from coal feed to ash disposal.
3. The poker action has been remodeled completely.
4. The driving mechanism has been simplified.
5. The ash pan now rotates intermittently.
6. A combined steam-jet and turbo-blower is provided.

The following results have been obtained:

1. Increased mechanical efficiency.
2. Greatly increased gas-making capacity.
3. More uniform quality of gas.
4. No clinking of the brick lining.
5. Hand poking entirely eliminated.
6. Reduced maintenance cost.

The cut shows the mechanical coal feed, which is a marvel of simplicity, reliability, and accessibility.

The essence of continuous producer operation is the poker, which in this bulletin is well demonstrated by a figure of the path described. Experience and tests have shown that it relieves the gas man from all hand poking. The poker is water-cooled with a minimum of flow.

The bulletin describes and illustrates the rugged Ash-Plow, the W-S-M steam injector blower and the steam turbo blower and the worm and gear drive.

A careful analysis of fire conditions is included with several valuable charts and tables. A series of tests made with a broad variety of coals, both high and low ash, high and low sulphur are given in detail. Several pages of producer gas information are also incorporated.

BOOK REVIEW

National Association of Cost Accounts Year Book.—A review of the Third International Cost Conference held at Atlantic City, September, 1922, with complete reports of officers and directors.

Papers on actual costs as compared with replacement costs.

Sales and administrators' costs.

Standards as a means of reducing costs.

Budgets, their construction and use.

The place of costs in business management.

Cost problems.

The book contains a complete list of members, with all chapter officers. 450 pages, cloth, price to non-members, \$3.00.

Optical Methods in Control and Research Laboratories.—By Goldsmith, Lewis and Twyman. A revised and enlarged second edition on Spectrum Analysis, Absorption Spectra, Refractometry, Polarimetry.

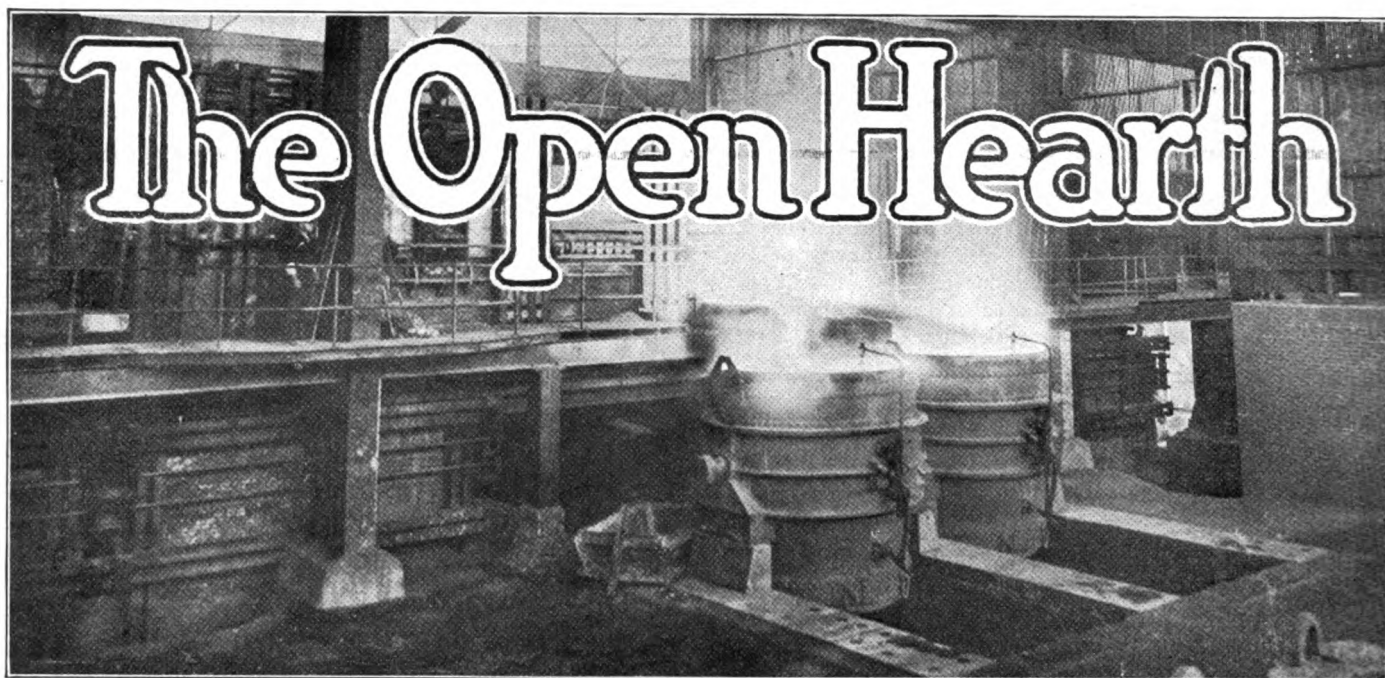
Changes in molecular complexity of solutions of cupric chloride when alone and when associated with other salts have been investigated by reference to spectrophotometric data (G. H. Getman, J. Physical Chem., 1922, 26, 216-246).

Spectrophotometric identification of phenols claimed the attention of H. Gsell (Zeit. anal. Chem., 55, 1916, 417). The phenol is converted into the alkali salt of its phthalein, and identified by the position of the absorption band.

A study of the extinction coefficients of the three chief proteins of blood serum, namely, albumin, pseudo-globulin, and eu-globulin by S. Judd Lewis (Proc. Roy. Soc., B, 1922, 189), led to the hypothesis that each of these proteins is composed of two or more proteid substances in physical association.

Charles Dhere has investigated the ultra-violet absorption spectra of several substances of physiological interest, of which the following may be mentioned: sarcine (6-oxy-purine), xanthine (2,6-dioxypurine) uric acid (2,6,8-trioxy-purine), which under equal conditions absorb light as far as wavelengths 2748, 2872 and 3060 Å. respectively, signify that they form a series (Compt. Rend. 1905, 141, 719). The spectroscopic properties of vegetable pigments have been investigated. Chlorophyll has been shown to exhibit several bands, and, in the pure state, to be remarkably transparent in the extreme ultra-violet. Carotin and xanthophyll have been similarly studied.

A 56 page hand book well illustrated, bound in cloth. Published by Adam Hilger, Ltd., London.



Dr. W. H. Maw, for the past 50 years editor-in-chief of *Engineering*, London, has been awarded the Bessemer gold medal by the British Iron and Steel Institute. This is in recognition of his work on the metallurgy of iron and steel. Although he is 85 years old, as head of the Institution of Civil Engineers he recently gave an exhaustive presidential address in person. He has been a member of the Iron and Steel Institute for 49 years.

R. W. Williams has been appointed southwestern district manager for both the Westinghouse Airbrake Company and the Westinghouse Traction Brake Company, Wilmerding, Pa., with headquarters in St. Louis. Coincident with the announcement of Mr. Williams' promotion, the American Brake Company, St. Louis, announced his election as vice president of that company. Mr. Williams has been with the Westinghouse Airbrake Company since April 1, 1902. After remaining at the general office in Wilmerding for seven years he was transferred to the southeastern district office in Pittsburgh. In 1910 he went to the Cincinnati office, and two years later was assigned to the Atlanta, Ga., office. He returned to the Pittsburgh office in September, 1920, where he served up to the present.

Alfred G. Way has been elected treasurer of the Fafnir Bearing Company, manufacturers of bearings and hangers, New Britain, Conn.

William D. Ferris, formerly manager of Stanley Works, Great Barrington, Mass., has been made manager of the Shelby Steel Products Company, Shelby, Ohio.

Frederick L. Pierce, treasurer Cutler-Hammer Mfg. Company, Milwaukee, has been elected also first vice president to succeed A. W. Berresford, who recently resigned. Frank R. Bacon was re-elected

president. Beverly L. Worden was elected second vice president, a new office.

C. W. Pearson, who has been associated with the Buffalo Foundry & Machine Company in various managerial positions for a number of years, and for the past year in charge of sales, has been elected vice president and treasurer. In addition to the new duties he will continue as director of sales. P. J. Krentz, who for several years has been works manager, becomes vice president and as in the past he will continue actively in charge of manufacture and production. Both Mr. Pearson and Mr. Krentz have been with the company almost from its beginning.

Emmett B. Carter, an engineer of the Midvale Cambria Companies, has resigned to accept a position with the Barrett Company, 40 Rector Street, New York. He was chief engineer of the Midvale Steel Company when it was bought by the Midvale Steel & Ordnance Company and has continued with that organization. For the last two and one-half years he has been construction engineer at the Cambria plant at Johnstown, Pa.

E. J. McCarthy, for several years secretary to C. L. Miller, vice president American Steel & Wire Company, Pittsburgh, has been assigned to the office of George W. Jewett, in charge of operations at the wire mills in the Pittsburgh district. Mills of the company in Braddock, Rankin, Donora, Farrell and Allentown, Pa., and Trenton, N. J., are grouped as Pittsburgh district mills.

J. T. Trumble has been appointed experimental engineer of the Olds Motor Works, Lansing, Mich. He has been identified with the automobile industry for several years and was recently with the Samson tractor division of the General Motors Corporation.

Louis Obrecht, formerly chief engineer and general manager of the Superior Steel Spring Company, Mt. Clemens, Mich., has been appointed as chief engineer and plant manager of the Saving Spring Company, Ashland, Mass.

J. Dalton is president and T. C. Frazer secretary of the Dalton Malleable Castings Company, Warsaw, Ind., which recently was organized.

Mervin Kessler, for the past four years superintendent of the Athol Machine Company, Athol, Mass., has been appointed general manager to succeed H. R. Linton, resigned.

G. E. Croak has been appointed superintendent of the Davis-Farnum Mfg. Company, Waltham, Mass. The company operates an iron foundry, machine shop and pattern shop.

M. F. Cunningham has resigned his position with the Superior Corundum Wheel Company, Waltham, Mass., and now is associated with the Waltham Grinding Wheel Company as general manager.

J. L. Simmon, formerly general manager of the Union Malleable Iron Company, East Moline, Ill., has been appointed general manager of the Canton, Ohio, plant of the Dayton Malleable Iron Company, Dayton, Ohio.

W. H. Geesman, who has been connected with the iron and steel industry for 20 years and for the past 18 months in charge of the iron and steel department of the Walsh Fire Clay Products Company, St. Louis, has been promoted to works manager of the Walsh properties.

John Scanlon has been appointed superintendent of the tinhouse of the Farrell, Pa., plant of the American Sheet & Tin Plate Company, Youngstown, Ohio. He succeeds Baker Boyd.

NEWS OF THE PLANTS

The Southern Sheet Steel Company, Chattanooga, Tenn., recently organized, is arranging for the immediate construction of its proposed new plant on site secured on the Tennessee River, near the city, consisting of about 33 acres of land. A number of mills will be constructed with a total length of 2,000 feet, including rolling mill with capacity of about 55,000 tons per annum, sheet mills, and auxiliary operating departments. Two open-hearth furnaces will be constructed with an annual rated output of 60,000 tons. The manufacturing process will be complete from ore to pig iron, and to finished steel. The plant is estimated to cost approximately \$1,500,000, including machinery. A. J. Lynch is general manager in charge.

The Welland Alloy Steel Corporation, Welland, Ont., has preliminary plans under way for the construction of a new furnace at its plant, as well as a large rolling mill. The company recently acquired the local works of the Electric Steel & Metals, Ltd., and has made a number of improvements and extensions in the plant. It consists of two 7-ton electric furnaces, with gross capacity of 15,000 tons a year; the new furnace will be of Heroult type and approximately of the same size. The works will specialize in the production of nickel alloy steel from ore secured from the Sudbury district, and in full blast will give employment to more than 1500 operatives.

The Central Coal & Iron Company, Holt, Ala., has awarded a contract to the Ingalls Iron Works, Birmingham, Ala., for the erection of an addition to its local plant, estimated to cost approximately \$80,000, including equipment. It is expected to use the extension for steel pipe and kindred production. The work will be placed in progress at an early date.

The Roehm & Davison Company, 6452 Mack Avenue, Detroit, Mich., manufacturer of steel products, has awarded a general building contract to Everett Winters, Book Building, Detroit, for the erection of a new addition to its plant for considerable increase in production. The structure will be two-story, 150 x 153 feet, located on Mack Avenue, and will be used for general steel production. It is estimated to cost approximately \$100,000, including equipment. Work will be placed in progress at once.

The Steel & Tube Company of America, Chicago, Ill., recently merged with the Youngstown Sheet & Tube Company, Youngstown, Ohio, under the direction of the latter organization, is perfecting plans for extensive additions in its plants at East Chicago and Indiana Harbor, Ind. The work will include a number of new mills, furnaces and miscellaneous structures, and is estimated to cost in excess of \$5,000,000 including machinery.

The Powell Pressed Steel Company, Hubbard, Ohio, has preliminary plans under consideration for extensions and improvements in its plant, and purposes to increase the present capacity more than one-fourth. To provide in part for the expansion, a preferred stock issue of \$200,000, is being sold. The plant is now running at full capacity with full working force, and will be continued on this basis for an indefinite period. The company is said to have large advance orders on hand.

The Replogle Steel Company, New York, N. Y., is completing repairs at its large blast furnace at Catasauqua, Pa.,

including the relining of the stack, and plans to have the unit ready for service at an early date. It will be blown in, it is said, with a full operating force, with expectation of keeping in blast for many months to come. The company is also arranging for extensions in its furnaces at Wharton, N. J., and the second stack will be blown in shortly. A full working is being employed, and operations are also being advanced at the local iron ore properties.

The American Sheet & Tin Plate Company, Frick Building, Pittsburgh, is arranging an expansion and improvement program at its plant at Chester, W. Va. The project will consist of the installation of additional equipment, with new buildings and remodeling of present structures, and is estimated to cost close to \$150,000. Work will be commenced at an early date.

The McKinney Steel Company, Cleveland, Ohio, has authorized the construction of two new blast furnaces at its local plant, designed to replace two old hand-filled type furnaces which have heretofore been used and which will now be dismantled. The new units will have a rated capacity of 600 tons each, and are expected to be ready for the torch within the next six or seven months. The company also has plans under consideration for other extensions in the plant.

The Perry Iron Company has awarded to Arthur G. McKee & Company of Cleveland, Ohio, a contract for rebuilding their blast furnace plant at Erie, Pa. The program includes the complete dismantling of the present furnace above supporting columns and of other portions of the plant equipment. The new furnace will be equipped with a McKee revolving stock distributor and all modern labor saving devices. A complete new storage and charging system will be installed, including ore and stone bins, coke bin, skip bridge and electrically driven scale car. All of the dismantling work as well as the design and construction of the new plant will be handled by Arthur G. McKee & Company.

The Inland Steel Company, Chicago, Ill., has awarded general building contracts and will commence the immediate erection of additions to its plant at Indiana Harbor, Ind. The work will include a large extension to the open-hearth department, estimated to cost in excess of \$100,000. A new rolling mill will also be built, to be used primarily for the production of merchant bars and strip steel. The working force will be considerably increased as soon as the new plant units are ready for service.

The Carbon Iron & Steel Company, Parryville, Pa., has completed improvements and repairs at its furnaces, and has resumed production with a working force of about 100 men. The plant has been dark for a number of months past. It is expected to develop capacity operations gradually, and additional workers will be employed.

The Joseph E. Thropp Company, Inc., Cumberland, Md., has taken title to the blast furnace at Everett, near Cumberland, heretofore held by Joseph E. Thropp individually. The stack will be improved and additional equipment installed for greater efficiency in production. The coke ovens will be placed in service at once and operations resumed at the limestone quarries.

TRADE PUBLICATIONS

A new fire cement has been developed by the Harbison-Walker Refractories Company. The trade name given it is Thermolith. This material and its uses are described in a new 8-page bulletin. Owing to the fact that this company has long occupied a pre-eminent position in the refractories industry, there has been some comment on the fact that it has not previously put on the market a commodity of



this nature. The explanation lies in the adopted policy of the Harbison-Walker Refractories Company not to put a fire cement on the market until one has been developed which was all that a fire cement should be --which was actually and beyond doubt superior to fireclay and other ordinary cements as a bond for fireclay brick. Thermolith is such a fire cement. It is the result of long experiment by experts in the Harbison-Walker research department, and it is backed by the vast experience and wide knowledge of this company in the refractory field. Thermolith sets hard and bonds fireclay brick firmly without heat. (Fireclay and many other fire cements are incapable of bonding firebrick at ordinary temperatures.) Thermolith remains absolutely a bond at all working temperatures; extreme heat conditions neither fuse it nor crumble it. In other words, it is a high temperature cement and a low temperature cement. Thermolith does not flux the brick at any working temperature. It can not because it is chemically neutral. This same quality also enables it to resist the action of basic slags and clinkers. Thermolith is mechanically strong. It withstands vibration, either of furnace charge or mechanical equipment. Thermolith is fool proof—one cement for many purposes. It is just as efficient for one heat condition as for another. Thermal tests which have been conducted show Thermolith unfused at even the highest working temperatures, and in abrasive tests it has been impervious to sand blasts of sufficient force to wear down fireclay brick. Thermolith comes in dry powdered form. It is applied with a

trowel after simple mixture with water. It does not require covering with water to prevent deterioration when not in use after package is opened. It is packed in 200-lb. air-tight metal drums. Thermolith is recommended for use in laying up fireclay brick in blast furnace and blast furnace stove linings; boiler settings and firebox arches, heating, forge and welding furnaces; copper, lead and zinc furnaces; cement, lime and pottery kilns; gas regenerating linings; glass pot furnaces and glass lehrs; brass furnaces, and other miscellaneous uses. Thermolith is also of great value in patching and repairing fireclay brick construction, such as in the boiler and gas generating practices, where rapid and effective repairs are a requisite for uninterrupted service. This cement is also effectively used as a coating on refractory surfaces for protection against abrasive, corrosive and chemical attack.

Accuracy of 0.1 in 60 seconds is attained in a portable timing device, described in Bulletin No. 460053, recently published by the General Electric Company. This device consists of an encased clock, to be used with a standardized clock as a means of secondary timing, to supplant the stop watch. The portable timing device has applications which enable its use with graphic instruments, measurements of angular velocities, and for indicating a definite time interval ranging from one second to any whole number of minutes. As illustrated in the bulletin, the instrument consists of a clock, relays, and gear train which by adjustment can be set to meet different demands of service. Power is supplied from a local flashlight type of battery. Errors as great as 0.4 second are frequently introduced through the use of stop watches, according to this bulletin, which quotes from an article, "The Limitations of Stop Watches," by A. L. Ellis. In addition to cutting the possibility of error down to 0.1 second, the portable timing device can be utilized for measurements ordinarily requiring a combination of instruments.

The pumping and water distributing system of the Lindsay-Strathmore irrigation project in Tulare County, Cal., is described in a well illustrated leaflet issued by the De Laval Steam Turbine Company of Trenton, N. J. This district is an irregular tract on the foothills of the San Joaquin Valley, 62 miles south of Fresno, and contains 15,500 acres, of which 8,000 are planted with oranges and lemons. The water supply is obtained by pumping from wells in the delta of the Kaweah River, and is lifted to the high level flumes and pipe lines by large centrifugal pumps driven by electric motors receiving power from a long-distance transmission line. It is well brought out that by good engineering and the use of modern, large and highly efficient

pumps, irrigation can be introduced in extensive tracts that were formerly either too distant from or too high above the water supply to make their development profitable.

Republic Flow Meters Company have compiled and are distributing three bulletins of great practical value to power producers and power users. The "Operation and Construction of the Republic Flow Meter" contains 16 pages full of information, cuts and tables not easily accessible to the average engineer. "Measurement of Steam" and "Power Plant Cost Accounting" should be in every executive's hands as a guide in the development of his plans for systematic management and campaign for closer economies.

Two valuable booklets have recently been published by Richards & Geier, attorneys, New York City. The second edition of "Patents, Law and Practice," a paper bound index of United States and foreign procedure, with schedule of charges; 55 pages. The third edition of "Trade Marks, Trade Names, Unfair Competition," 45 pages, paper bound, containing much material of value to companies and individuals. Sent on request.

Combustion Engineering Company of New York have just issued a 12-page illustrated pamphlet announcing their development of the Combusco Ash Conveyor. This is a distinctly new type of ash conveyor in America, although in successful service in Europe previous to its introduction here. Excellent views of different types of installations are shown, with a complete description of its manifold advantages over older types of equipment.

COMING MEETINGS

American Institute of Electrical Engineers Spring Convention, Pittsburgh, April 24-26; annual convention, Swampscott, Mass., June 25-29; Pacific Coast convention, Del Monte, Cal., Sept. 25-28. F. L. Hutchinson, 33 West 39th Street, New York.

National Electric Light Association — New York, June 4-8. M. H. Aylesworth, 29 West 39th Street, New York.

May 28-31 — American Society of Mechanical Engineers. Spring meeting at Montreal. Calvin W. Rice, 29 W. Thirty-ninth Street, New York, is secretary.

May 14-15 — American Society for Steel Treating. Spring sectional meeting, Hotel Bethlehem, Bethlehem, Pa. W. H. Eisenman, 4600 Prospect Avenue, Cleveland, is secretary.

June 25-26 — American Society for Testing Materials, annual meeting at the Chalfonte-Haddon Hall Hotel, Atlantic City, N. J. C. L. Warwick, 1315 Spruce Street, Philadelphia, is secretary.

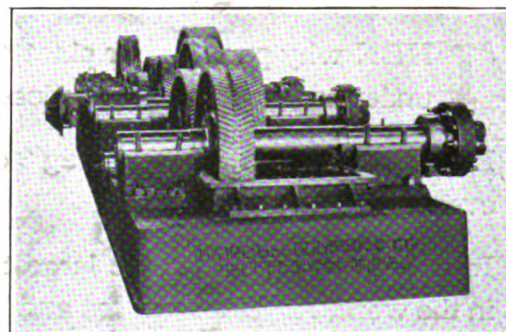
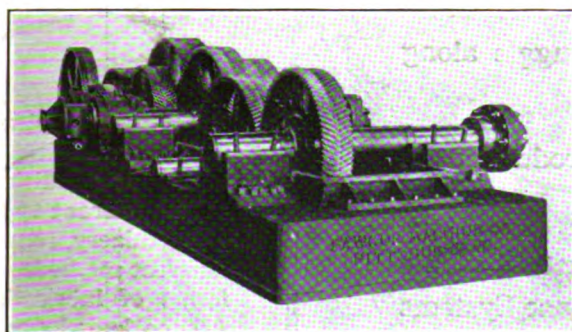
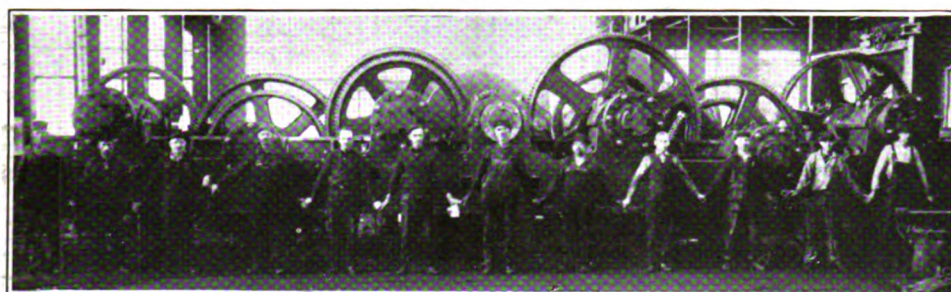
Consult the Power Plant Information Section in June

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The Blast Furnace and Steel Plant

Pittsburgh, April, 1923.



The above illustrations show under construction in our plant the largest Tandem Cut Herringbone Gear Drive that has ever been built. This unit is for driving a 6 stand 16-in. Continuous Bar Mill and is part of a contract for drives for this complete mill installation which in addition to the above consist of a 4 stand Tandem Drive for 12-in. Continuous Mills, 1 Drive for 2 stand 12-in. Loop Mill and Combination Herringbone Gear Drive and Pinion Housing for single stand 11-in. Finishing Mill.

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